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Edited by

Waiman Cheung,
The Chinese University of Hong Kong, China

Timon C. Du,
The Chinese University of Hong Kong, China

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Welcome Message from Conference Chairs

On behalf of Department of Decision Sciences and Managerial Economics of the Chinese University of Hong Kong, we would like to welcome you to Hong Kong and to the fifth International Conference on Electronic Business (ICEB 2005 Hong Kong). We hope you can enjoy the conference and the distinctive blend of East and West in this dynamic city.

ICEB 2005 Hong Kong is the fifth International Conference on Electronic Business which is offered by International Consortium on Electronic Business that was initiated by The Chinese University for Hong Kong, Hong Kong; National Chiao Tung University, Taiwan; Tsinghua University, China; and National University of Singapore, Singapore. The Consortium aims to be the leading forum for e-business knowledge and education in the world.

The aim of the fifth International Conference on e-Business is to foster the exchanges of research findings, innovative ideas and industrial practices in the area of e-business with particular emphasis on applications in logistics and supply chain management. ICEB 2005, the second time hosted by The Chinese University of Hong Kong at Sheraton Hotel and Towers, has more than 200 papers submitted and we collect 160 papers in the conference proceedings. The topics include decision support & group systems, Internet marketing & advertising, data warehousing & data mining, supply chain management & e-logistics, e-business models & enterprise e-service architecture, mobile commerce, Internet security & privacy, e-procurement, web intelligence, collaborative commerce, and others. We certainly hope this conference can provide a platform for exchanging the findings and issues in e-business.

The conference cannot be successful without your participation and the dedication of many colleagues. We would like to express our sincere appreciation for the support of Faculty of Business Administration, The Chinese University of Hong Kong; Centre for E-Business, National University of Singapore; Research Center for Contemporary Management, Tsinghua University; and Institute of Information Management of the National Chiao Tung University for co-organizing the conference. We would like to thank Professors Xiande Zhao and Jeff Yeung for their the great effort on serving as the program co-chairs, Professor C. C. Lee for serving as the chair for Doctoral Student Seminars, Professor Eldon Y. Li for the support from International Consortium on Electronic Business, and many colleagues for serving as international committee members. Also, the deepest gratitude to Li & Fung Limited, the sole and full sponsor, for giving us free hand on designing good quality of conference. Last but not least, we like to thanks our colleagues who dedicate to the conference, including Jessica Li, Roslind Sukendar, Kelvin Liu, Connie Vong, and many others.

We sincerely hope you can enjoy the hospitality extended by Department of Decision Sciences and Managerial Economics of the Chinese University of Hong Kong and your stay in Hong Kong.

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The Study on RFID Security Method for Entrance Guard System

Y.C. Hung¹, C.W. Tsai², C.H. Hong³

¹Andrew@mail.ncyu.edu.tw ²s0930316@mail.ncyu.edu.tw ³chhong@csie.ncyu.edu.tw

Abstract: The RFID technology has been used by industries in recent years, for examples, replacing the traditional two-dimensional barcode, logistics management, military applications, identification. In fact, RFID technology has become one of the new killer technologies. The RFID uses radio frequency to convey information which involves, however, many security problems; Current RFID guidelines do not present solutions to these security problems. The methods put forward in published paper fail to offer complete solutions, either. This study identifies RFID security method for Entrance Guard system. The algorithms used include Hash, AES, random values, XOR four item technology, and use the three-way authentication structure to solve the safety problems of the certification of Entrance Guard system. The experiment showed the algorithms provided better protection on the current RFID systems against attack methods such as Eavesdropping, Traceability, Spoofing and Replay attacking.

Keywords: RFID, RFID Smart card, AES, HASH.

I. Introduction

Since World War II, RFID technology which was used for identifying enemy's or our flights has been over 60-year evolution. Now, in the big enterprises with over 5 billion US dollars annual sale worldwide, 70% of them has create RFID technology plan. This shows RFID technology has drawn the attention from general merchandise, retail business, government, storehouse industry, and so on, so RFID technology has just become the application in the top class of the new generation. Apart from being used on the logistics management, another application of RFID is to insert RFID tag into Smart IC card. This type of application is quite extensive, for example, Taipei MRT pass card, identification card of entrance security of multi-storey buildings, work ID from government and schools, student ID, and so forth. Through RFID wireless transmission and features of non-contact, the original issues of inconvenience and fabrication on the use of contact smart card. However, due to the RFID using wireless frequency to communicate and carry information as well, its new security issue has also gradually appeared. In additional, the issue of RFID system security has not yet been fully regulated in the book of national normal standard, so this issue is quite controversial.

In this study, RFID tag frequency is 13.56MHz, and according to ISO/IEC18000-3, it belongs to Passive Tag. There is no place for batteries in the tag, and the size is

restricted, so the ability of calculation for the tag is limited with the small capacity of the memory. Therefore, the use of traditional encryption calculation and authentication mechanism cannot be applied. For this reason, it is hoped to use four technologies such as Hash, AES, Random values, and XOR with the combination of the 3-side authentication framework to bring up less calculation and high security identification mechanism to RFID smart card which is hardware restricted, for solving the security concern of the current use of RFID smart card identification and entrance guard system. Besides, with the difference of general security identification mechanism, this study has been added in active defence mechanism, for further enhancing the security of system, and reducing the opportunity of the data in RFID smart card to be eavesdropping, spoofing, traceability.

II. Background Knowledge

II.1 RFID

RFID stands for "Radio Frequency Identification" system, and it is similar to Smart card system. It is developed due to the defect of contact system by using radio frequency and carrying digital data, so the identification card and card reader do not need to contact each other but complete the exchange of data. Consequently, there is no requirement of direction under this way of carrying data, and the card could be immediately identified when it is put in the bag or purse. It's a chip of mini two-sided radio waves with card-pasted style, and only uses two connected point to connect one simple IC to another antenna, so the installation of receiving signal could be done. When the question of the electromagnetic remote wave was sent out, the card could right away to answer the required information by digital radio frequency signal, while RFID is composed of 4 parts, such as RFID tag, RFID reader, Backend database, frequency radio.[1][2]

(1) RFID tag

It is pasted or inserted to merchandise, goods, RF chips in smart card, and the main structure includes CLK circuit, AC to DC commutation wave filter, demod, codec, ip, memory.

RFID tag can be divided into two different types, active and passive:

◎ Active Tag

With one build-in small battery, the capacity of memory could reach 1MB, and there is longer radio communication distance (100 meters) by using communication, but there is limitation of deadline which is about 7 to 10 years, so the

cost is relatively high.

◎ Passive Tag

No build-in batteries, the coil inside the tag could send electric field out by readers to get energy. Due to the use of electromagnetic induction, the communication distance is short, and the cost is lower, small size, long duration with more competitive ability, so it highly possible to become the mainstream of market. There is a comparison between active and passive RFID tag in table 2-1 below.

Table 2-1 The comparison of tags

	Active	Passive
Power installation	Build-in	No Build-in
Valid period for use	Yes	No
Environment Condition	More Sensitive to high and low temperature	Can adapt to worse environment
Price	higher	Lower

(2) RFID reader

Reading, receiving past or inserting merchandize, goods, receiver of RF tag in the smart card. The main structure concludes: PLL, VCO, Demod, Codec, uP, Memory, time record generator. RFID reader can use antenna to read and write. Different RFID system has different type of antenna. For example, the reader in the entrance of supermarket: because the goods carried in different height, the antenna could be high as a person's height. The antenna do not need to activate tag anytime, but activate the transmission by cooperate the sensor in the food pad. Readers can be divided into two types: fixed and portable. The former can be place in the entrance of the supermarket, good shelves, warehouse entrance, wagons, container yard entrance, airport, and so on. The latter one is much lighter, with direction and shorter distance of interaction.

(3) Back-end database

The main function is to record details of the RF tag, when the reader received RF tag signal, it will link either by wireless or wire network to back-end database, to get the integration of details of RF tag for other application to use.

(4) Frequency radio

The frequency of RFID is to link the information transmission between tag and card readers. The frequency is sent from card readers out to tag, and the tag returns the information inside the tag. The option of frequency is mainly based on the distance between RF reader and RF tag. A lower frequency means a lower range of reading, and slower information transmission. But in the metal and humid environment, high frequency relatively has better reading ability. Besides, it depends on the frequency opened by each

country. Every country uses different frequency. Generally speaking, the information transmission and communication frequency between FR readers with low frequency and RF tag are not controlled by government, but the ultra high frequency would be restricted. Take Japanese government as an example, the frequency of 950~960 MHz has been decided to open for RFID system to use. RFID system could be categorized by frequency into four: Low Frequency (LF,125KHz ~ 135 KHz), High Frequency (HF,13.56 MHz),Ultra High Frequency (UHF , 100MHz~960MHz), Microwave(over 1GHz).

II. 2 RFID Security Issue

RFID system carry information by wireless, so if RFID system does not provide complete security mechanism, then within the available range of information transmission, the attackers can randomly access, falsify, delete, and damage the information of RFID tag. This weakness has obviously threatened the organization, enterprises, personal information security and privacy. In the following text, the weakness of RFID used by attackers and may cause security problem attackers will be indicated.

A. Eavesdropping

Because RFID system uses wireless to transmit information and communication, the attackers could eavesdrop the information and message during the communication between reader and tag. So the way of this type of attack is called "Eavesdropping". In the transmission of RFID system, it can be roughly divided into reader-to-tag(forward channel) and tag- to-reader(backward channel). Forward channel came from reader, so the distance is long and the range is big (100meter), so it is easily to be eavesdropped without being noticed easily. Backward channel came from tag, so the distance is short, and the range is smaller, so it's more difficult to be eavesdropped without being noticed easily. As Figure 2-1 shown:

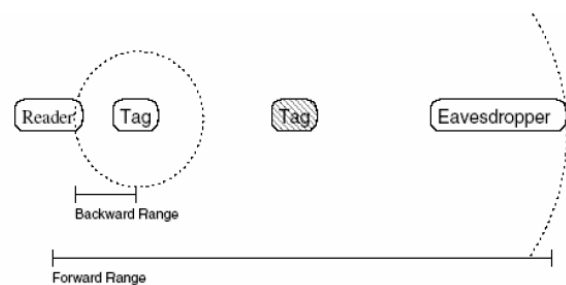


Figure 2-1 Forward、Backward range

The security issue of eavesdropping will cause two serious damages: the exposedness of personal information and business spy.

(1) The exposedness of personal information

In the aspect of the exposedness of personal information, this has been widely used in RFID smart card which save card holder's personal information. For example, health insurance card stores medical record, personal information,

and so on. For they are the information that card holder would not want to make known to the public, and necessary to be protected. However, because RFID system belongs to non-contact card, so the opportunity of being exposed is relatively higher.

(2) Business spy behavior

Nowadays, the industry of manufacture, logistics, retail, and military institute give every effort to popularize the use of RFID system, and RFID relatively brings quite a lot of benefit, convenience. However, under the tendency of RFID, the issue hidden behind would be monitored by attackers, the risk of being stole on information. RFID system could make the factory owners use the information stored in the tag memory to quickly get product name, model number, material, logistics procedure, and so on; on the contrary, the attackers could also get and monitor the product information in the same way. Therefore, the activity of business spy would become worse, and then lead to serious consequence if there is no further prevention of security mechanism.

B. Traceability

In RFID system, RFID reader could get the information and trace product through the returned message RF tag. It is also this feature that attackers could trace product and users through the returned message from FR tag, so it is called "Traceability". The main reason that attackers could trace tag is because normally the returned value from tag is fixed and unchanged. Some tag returns UID value directly, and this UID is also the unique identification value of RF tag. Therefore, attackers only have to set readers in many fixed point, then they could trace products and users. For example, sneaker factory owners want to carry out logistics and storehouse management, so they insert RF tag chip into shoes, and when customer A bought this shoes, then attackers could trace the customer A through the fixed RFID reader and make customer A's privacy public.

C. Spoofing

After the introduction of two security RFID issues of eavesdropping and trace, another issue is "Spoofing" which includes two major items: Theft and Counterfeiting.

(1) Theft

Through deceiving legal RF tag, attackers could deceive automatic book close system, entrance guard security system by RFID system features. For example, attackers could rewrite RF tag information or replace the RF tag information inside expensive goods with that inside the cheaper ones. Or attackers could falsify a host of RF tag to mess up the whole management of the supply chain.

(2) Counterfeiting

Counterfeiting is defined as can be read or intercepted to falsify the information of RF tag. Attackers could deceive RFID system through falsifying RF tag information. For

example, they could forge IC card of entrance to invade company or military institute.

II. 3 RFID Existing Security Strategy

The solution of this RFID security issue could be divided into two categories: Non-Cryptographic Scheme and Cryptographic Scheme. There will be a brief description of several important solution: "Kill tag approach" in "non-Crypto-graphic scheme" and Hash based access control, Randomized access control, Hash chain in "cryptographic scheme". [3][4][5][6][7][8]

A. Kill tag approach

In order to prevent the occurrence of security issue when users get RF tag, the solution is to delete its memory information before they get it. The way is to put one 8-bit password in every RF tag, and then run "Kill" command. However, there are two problems existing in "Kill tag approach". One is the support from the manufacturing factory is required, and the other one is that to ensure the Kill command has been actually executed is difficult.

B. Rewriteable memory

Separating memory in RF tag into ROM and RAM, ROM can store public information, and RAM can store private information. Readers have to be authenticated before accessing RAM, with the implement of cryptographic scheme.

C. Hash based access control

Irreversibility of Hash is mainly to be used for authentication. Its structure is as Figure 2-2 shown:

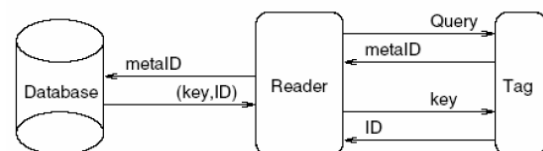


Figure 2-2 Hash based access control

In RF tag, metaID (metaID = has (key)) will be stored firstly. When readers query RF tag, RF tag would return metaID, and reader can search the back database to find the matched key value to complete authentication. This method could solve the problem of RF tag information being eavesdropped, but because the returned metaID value from RF tag is fixed, so it cannot prevent attacker's trace.

D. Randomized access control

This method is used to improve the issue of Hash based access control to be traced. Adding one random value R in the returned value, so the returned value that reader queried could be changed. Its returned value is $\{R, h(ID_k \parallel R)\}$ and the structure is as followed in Figure 2-3:

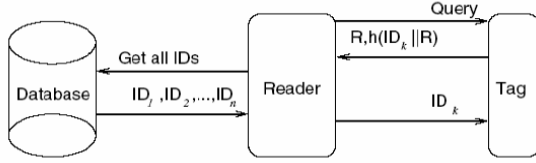


Figure 2-3 Randomized access control

E. Hash chain

In RF tag, storing on initial value $s(s_1)$, and the way of communication with readers is similar. Only the returned value changed to $a_i = G(s_i)$, and after responding to readers, it would immediately changed to $s_{i+1} = H(s_i)$ where G , H are hash function. Its structure is as followed in Figure 2-4:

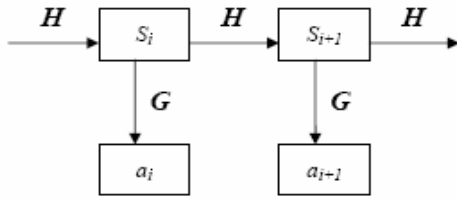


Figure 2-4 Hash chain

III. System Structure

III.1 System Introduction

In current entrance guard systems, most of them use RFID smart card for user identification. This RFID technology gives the convenience and speed for identification check but this convenience also relatively generates the security issues. In this research, we provides a symmetrical encryption method (AES, HASH, Random value) and three-sides identification in the entrance guard security system structure of RFID smart IC card. This system structure not only protects the user information privacy, counterfeit prevention, and identity theft, but also protects the card holder to be traced. Besides, different from other security system structure with focus on the passive security shield, this system also provides active detection for smart IC Card security. After the card is attacked, the system will automatically turn on the reaction procedure to increase the security level on information and privacy protection. The system structure is depicted as Figure 3-1.

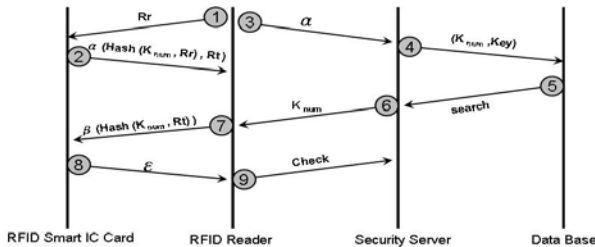


Figure 3-1 System Framework

The RFID smart IC card discussed in this research is the RF tag with frequency at 13.56Mhz. So the standard from ISO / IEC 18000 specifications should be followed. As a result, there will be some limitations for the hardware. In this research, we will embed a hash calculator, random generator and several logic gates in the RF tag, which will not violate the hardware limitation rules from the specifications. Before introducing the system structure flowchart, we can define the database structure saved inside the RF tag and security system database. $\{S_count, Key_num, P_k(Data)\}$ is the database structure in RF tag. S_count records the scan counts for this RFID smart IC card by RFID reader. K_num is the identification serial number of the user data encryption key in this RFID smart IC card. $P_k(Data)$ is the encryption code of card holder information encrypted by the K_num key. There are $\{K_num, Key_i\}$ and $\{ID, S_C_count\}$ in the structure of security system database, in which Key_i is one of the key used in system encryption, K_num is the corresponding identification serial number for Key_i , ID is the user identification code and S_C_count is the identification number of times between the record system and card holder. The system data structure is depicted as Figure 3-2 in below.

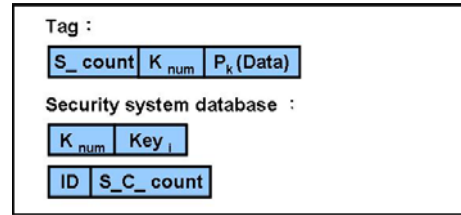


Figure.3-2 Data Structure

System flow

Here we will categorize in nine steps to explain the system flow structure from Fig3-1.

(1) When the card holder use RFID smart card to precede the identity confirmation, RFID reader will generate question message to the RFID smart card after the card holder puts the card within the save and read range of RFID reader. This question message includes R_r value, which is a 128bit random value generated by the reader.

(2) When RFID smart IC card is inside the reader sensor region, it will add the S_count value in the RF tag by the power from electromagnetic induction. Then it will generate α message as reply from the equation $\alpha = \{F_t(K_num, R_r) || R_t\}$. F_t is a hash function embedded inside the tag and R_t is the random number generated by the random code generator. The transfer format of question message from RFID reader and α message replied by IC card will use the standard of communication structure defined in ISO/IEC 18000-3 specification book, as illustrated in Figure3-3 and Figure3-4.

SOF	Flags	Com code	IC Mfg	UID	Signed data Rr	CRC	EOF
	8 bit	8 bit	8 bit	64 bit	128 bit	16 bit	

Figure 3-3 Query message

SOF	Flags	UID	Signed data α	CRC	EOF
	8 bit	64 bit	128 bit	16 bit	

Figure 3-4 α message

- (3) RFID reader gets the α value and sends it back to the backend system for identification comparison.
- (4) Security system searches the saved K_{num} in the backend database then it will compares $F_r(K_j, R_r)$ and α value.
- (5) The system will send the Key_i and K_i , which are generated from the IC card of the card holder, back to the system. After full search in all K_{num} , the system will send back error message if it cannot find the matched K_i .
- (6) RFID reader will send β message in order to get the card holder information from RFID smart IC card, in which $\beta = F_r(K_i, R_t)$.
- (7) After RF tag confirms β message, it will try to compare to see if K_i and K_{num} are the same.
- (8) Make sure β message is correct, feedback ϵ from $\epsilon = (P_k \text{ (Data)} \parallel S_count) \oplus F_t(R_r)$.
- (9) RFID reader will process the identification procedure though the Key_i , R_r , S_C_count value from the card holder. The identification process will get $P_k \text{ (Data)} \parallel S_count$ from $F_r(R_r) \oplus \epsilon$ and then use the key to get the value of $P_k \text{ (Data)}$.

The 9 steps in above is the passive mode processing steps for security identification system. However, we also mentioned the active mode security identification system. The procedure will be addressed in below. According to the real needs, the system will define two security entrance guard values (T1 and T2). From the security identification step (9), the security system will get the S_count value from the ϵ message. After the calculation of S_count and S_C_count difference value (n), it will compare the n value with the entrance guard value defined by the system. If n is larger than T1, the system will warn the card holder and inform that the card might be attacked. If n is larger than T2, the system will lock this RFID smart IC card and request the card holder to activate the card from the IT department. The security system administrator will use different key for encryption and change K_{num} value for card holder's personal information. By this method, the system will be able to perform the active security shield to enhance the security in the identification system.

III. 2 Security Analysis

In the second chapter, we have discussed the security problems in the RFID system. In this section, we will do the security analysis for the security identification process from the security problem in the RFID system in order to proof the security structure in this system. In this research, we assume that RFID reader, backend data transfer and communication are all inside a safe environment. Therefore, the research will not cover the discussion in security topics in RFID reader and backend data transfer connection line.

A. Eavesdrop

From the transfer structure inside this system, the data transfer (See Fig 3-1, step 8) in this identification process of RFID smart IC card and RFID reader (See Fig 3-1, step 1, 2 and 7) is protected from the hash function encryption. The hash function contains irreversibility which means that the attacker could not reproduce the original message even though this message was eavesdropped by the attacker. Besides, two random numbers (R_r and R_t) are used in this identification process which offers different message for each identification process to increase the difficulty of force methods by the attacker. During the information transmission from the card holder, the system will send the information after the data process with $F_t(R_r)$ in xor calculation. The card holder's information was encrypted and saved in the RF tag memory. Though the attacker uses the stole R_r value to calculate $F_t(R_r)$ value and crack the xor calculation protection, the cost and time will be increased for attacker to crack and get the encrypted $P_k \text{ (Data)}$ based on several different encryption key used by the system. For example, it will cost 2^{128} to crack the information from 128bits key with AES encrypted calculation. If the key number is 2^5 , the cost will increase to 2^{640} for crack. Therefore, the attacker will not be able to steal the $P_k \text{ (Data)}$ value to solve the private information from the card holder.

B. Spoofing

In the entrance guard security system, the reproduction and theft of identification IC Card is a serious security topic. In this system, the attacker is able to get the $P_k \text{ (Data)} \parallel S_count$ xor $F_t(R_r)$ value by eavesdrop. If the attacker is able to analyze the interpreted $P_k \text{ (Data)}$ value to reproduce IC Card and deceive the security system, the identification procedure is required before the personal information check by the security system. At this time, the attacker must also hold this K_{num} value of the RFID smart IC card together to pass the identification procedure to the check process. However, the K_{num} value will be encrypted with hash function and random value in the transfer process. The attacker will not be able to get the K_{num} value by eavesdrop and to reach the goal of deceiving system with $P_k \text{ (Data)}$ value.

C. Traceability

In traditional RFID system, the attacker could trace the

card holder from the fixed replied message from the attacker reader's quote only by couple fix location RFID reader via the RF tag chip embedded inside the card holder's RFID smart IC card. In the security system discussed in this research, the message value from each communication transfer between the whole RF tag and RFID reader is not a fixed value due to the extra embedded hash calculator and random value generator inside the RF tag (See Fig 3-1, Step 1, 2, 4, 7, and 8). Therefore, the attacker will not be able to trace RF tag from the fix reply message.

D. Man-in-the middle attack

If the attack is sent after reproduction of legally obtained RFID reader and RF tag message, the attacker could get $(P_k(\text{Data}) \parallel S_count) \oplus F_t(Rr)$ value after performing Man-in-the middle attack. However, the attacker still encounters the same difficulty in the spoofing attack as discribed above. The attacker has to cract two encryption procedure to obtain the card holder private information. So this security system structure is able to prevent Man-in-the middle attack.

E. Replay attack

If the identification is not passed either in security system side or RF tag side, the system will stop the reply message immediately. Besides, the system uses two random numbers and active security shield mode so that resending attack is not able to attack the system.

F. Active reaction procedure

Different than other security system, we added two calculated value (S_count , S_C_count) and two security entrance guard values ($T1$, $T2$) in the RF tag memory. If the attacker's RFID reader attempts to save and get this RFID smart IC card, S_count and S_C_count will generate difference once the identification process is failed. If the identification process is finished from the legal RFID reader, the system will get the information inside the RF tag memory and compare the difference between S_count and S_C_count value. If the difference of S_count and S_C_count is larger than $T1$, the system will warn the card holder that the card might be attacked. If the differnece is larger than $T2$, the system will request the card holder to the security department to update the information inside the IC card. Different keys are used to re-encrypt the private information and modify the K_{num} value to ensure the system security and card holder's privacy. The reason to use this two stage entrance guard value is due to some unexpected

issue in transfer and communication failure between RFID smart IC card and RFID reader, such as the high humidity in the rainy days or RFID smart IC card was placed inside the metallic box etc. Therefore, two entrance guard values are used to prevent these unexpectable reasons from the inconvenience of frequent changing card information.

IV. Conclusion

The development of RFID technology brings significant convenience to people but its security is also a big drawback. Without providing solutions, it will seriously affect the information security from personnel, company, military to government. This research provides an identification system for RFID smart card entrance guard system with Hash, AES, Random values and XOR technologies. Combined the identification from three sides, the goal is to resolve the security issues for RFID smart card, such as eavesdrop, traceability and counterfeit etc. In addition, the embedded RF tag hardware also meets ISO/IEO 18000-3 standard to proof the execution possibility. Besides, the active shield system was added in the structure to enhance the strength of the security systems to prevent the potential danger of system failuer from the attacker by resending attacks or Dos attacks to the system.

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Building Ubiquitous Computing Environment by Using Rfid in Aircraft MRO Process

Cheng-Yuan Ku, Yi-Wen Chang, Mi-Cheng Lu, Shu-Fang Chiu

Department of Information Management, National Chung Cheng University, 168, University Rd., Min-Hsiung, Chia-Yi, Taiwan, R.O.C.

Phone: 886-5-2720411 ext. 34603

Fax: 886-5-2721501

Email: {cooperku, azure, mimilu, labrador_nobody}@mis.ccu.edu.tw

Abstract: The implementation of RFID had aroused discussion in every area. Experts believe that the emergence of RFID will cause another business revolution. Many industries had deployed RFID, like aviation industry, in which RFID is used in maintenance materials and baggage management. This paper discusses the implementation of RFID in MRO process and the building of a ubiquitous computing environment. We believe that our proposal has three merits to MRO (1) anti-counterfeit parts (2) MRO liability (3) efficient and effective inspection. The architecture can address the competition pressure that aviation industry faces and consequently enhance competition advantages.

Keywords: Personalized, Mobile, and Ubiquitous E-service.

I. Introduction

Ubiquitous computing, or Ubicomp, first proposed by Weiser, is the method of enhancing computer use by making many computers available throughout the physical environment, but making them effectively invisible to the user [5]. Ubicomp enables users to access demanded services and information under various environment, and eliminate the media break that connect the virtual world (including ERP, IS, Internet, etc.), and the physical world (objects, person, assets). The applications of Ubicomp in business environment help improve business processing efficiency and eliminate human intervention during information processing. Among technologies that had been used to implement Ubicomp, RFID is the most practical and feasible one. RFID is not a new technology; in fact, it was invented during World War II [8]. Nowadays, it attracts attention from various industries and academics. RFID system comprises three primary components: tag, reader, and back end database [6][8][12]. RFID tag consists of antenna and electronic circuit [6][7][8][12]. The antenna transmits data or receives data from readers. The antenna also allows tag to couple to an electromagnetic (EM) field to obtain power [6][8][12]. The electronic circuit is divided into two parts: memory and logical gate. There are two kinds of memory, ROM and RAM, and their capacities range from hundreds to 1K bits [9].

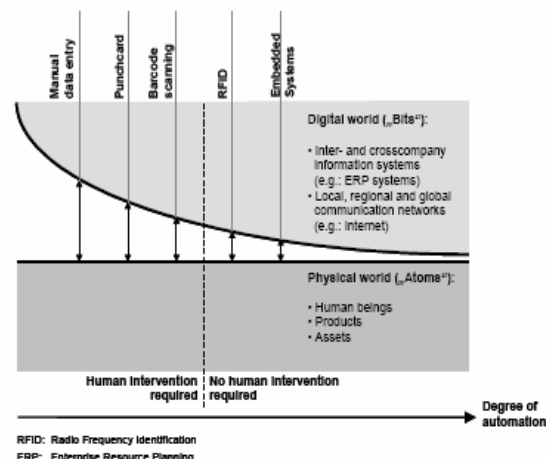


Figure 1 Media Break Between the Physical and Digital World [4]

There are about a few thousand of logical gates [12] to perform the basic computation in tag. Tag is categorized as passive or active and as low frequency or high frequency, depending on the power source and data transmission radio frequency [6][7][8][12]. Furthermore, RFID tag has many characteristics, for example, the unique identification, the basic computation, and its traceability. RFID is considered the successor of barcode. There are some applications of RFID system, for example automatic road toll collection, anti-theft systems, goods tracing and identification. The participants of aviation industry also notice this new application. Currently, the competition among aviation companies is intense due to the entering of new competitors and the stagnation of market growth. To conform to regulations, huge budget is spent on maintenance procedures. In aviation industry, aircrafts have to perform maintenance regularly. Such a process is called MRO (Maintenance, Repair, Overhaul) [1]. For safety reasons and public interests, the law enforcements, like FAA, have set up conscientious demands or regulations to make sure that the airline companies carry out MRO as requested.

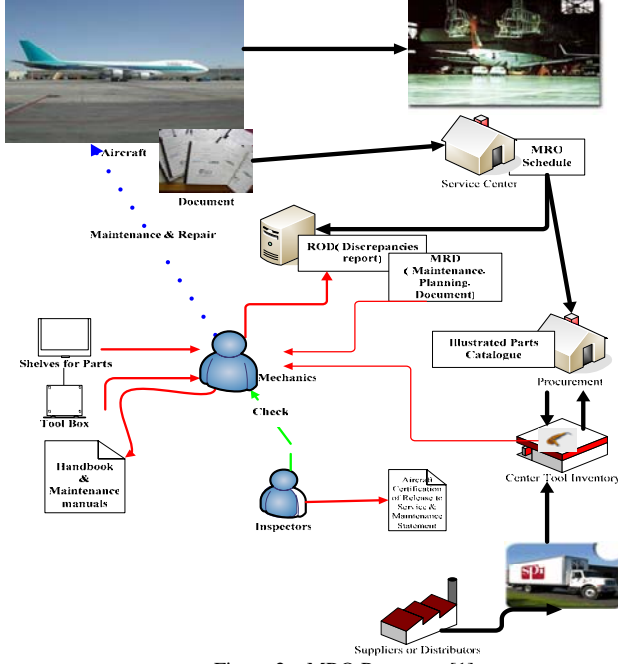


Figure 2 MRO Processes [1]

MRO is required every 650 flying hours, and it costs approximately 12% of total operation cost of an aircraft [1]. The opportunity cost of an idle aircraft is about US \$ 23,000 per hour [1]. Therefore, the airline companies are searching for solution to decrease costs and increase the MRO efficiency and effectiveness. In [1][4], the authors propose architectures that build the UbiComp environment to improve tool management and tool inventory management during MRO process by using RFID. The authors believe that this architecture will upgrade the MRO efficiency and maintenance accuracy. Not only academy, the aviation companies also perform RFID field test, like baggage tracking [11]. Boeing and Airbus had cooperated with FedEx to attach RFID tags in some aircraft parts, like onboard maintenance power. In 90-day test, all the RFID tags perform well. Boeing and FedEx expect that the RFID tags will be attached to all parts of aircraft in the future [2][3]. Delta Airline, working with Boeing, put RFID tags in components of engine. They look forward to the deployment of RFID throughout MRO process to provide better services [2][3]. Boeing and Airbus team up to set up requirements of implementing RFID and establish standards [10].

II. Motivation

We had reviewed many studies about using RFID to improve MRO. These studies all focus on issues of upgrade the level of MRO efficiency, but do not emphasize on the accuracy of MRO process [1][4]. In [1][4], the architecture aims to improve tool management and tool inventory by attaching RFID tags in tools. However, the proposed architecture cannot detect the possibilities that mechanics may skip standard maintenance procedures or miss some parts. We

believe that the accurate MRO is more important than efficiency. Besides, [1] and [4] do not address the fake parts problem, which costs the aviation industry US \$100 million each year. In our proposed architecture, we use the standard MRO procedure to sequence all replacing or repairing parts. By this means, it can hopefully ensure that mechanics follow the standard procedure to do their job and do not bypass any important step. We also introduce an approach to solve the problem of fake part, and it can be implemented in tags with limited computing power. Finally, to improve inspection process, we propose an electronic and credible certificated process. It provides the legitimate audit trails.

III. Architecture

III.1 Tag

The tag stores two types of data:

(1) **Unique Identifier (Tag_ID)**: This attribute follows EPCglobal standard and stores 96-bit electric product code.

(2) **Manufacturer's Authentication ($MAC_{\text{manufacturer}}(R)$)**: The Manufacturer first generates a unique random number R for each tag. Before the product is shipped to the customers, the manufactures will encrypt R by using MAC with secret key of manufacturer and then store it inside the tag. The secret key is only possessed by the manufacturer.

Tag_ID $MAC_{\text{manufacturer}}(R)$

EPC	*****
-----	-------

Figure 3 Data Format for RFID Tag

Tag_ID	R	CustomerID	Key
Tag_ID ¹	A1111111	Northwest	123456
Tag_ID ²	B2222222	Northwest	123456
Tag_ID ³	C3333333	Northwest	123456

Figure 4 Database of Manufacturer

The Manufacturer stores each tag's EPC, R , customerID, and key in database.

III.2 Before MRO

After the aviation companies received the parts they purchased, they will perform the following actions:

(1) **Authenticate Purchased Parts**: As illustrated in Figure 5, the companies start to authenticate these parts after the purchased parts arrived. MRO server is responsible for recording tag unique identifier (Tag_ID), which is generated by product manufacturers. The reader collects the Tag_ID and $MAC_{\text{manufacturer}}(R)$ and then sends to MRO server. The MRO server will wrap up these collected data along with CustomerID and send to the manufacturer. After the manufacturer received these transmitted data, it uses the key (manufacturer) to examine the received $MAC_{\text{manufacturer}}(R)$.

It also checks CustomerID to make sure that the aviation company does not receive the wrong parts. Finally the manufactures send all information, including the production date and expiration date, back to the aviation company if the whole authentication result is O.K.

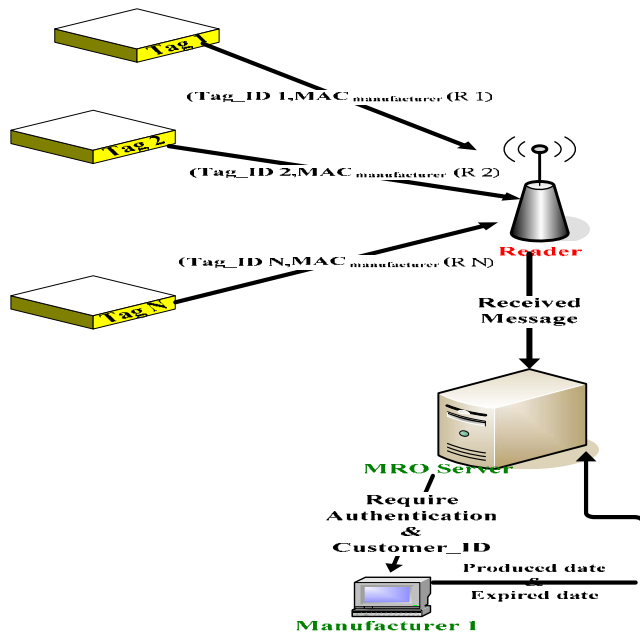


Figure 5 Procedure of Parts Authentication

(2) Prepare the MRO procedure: After completing the authentication process, MRO server records all corresponding information, including the production date and expiration date. The MRO server also arranges the MRO schedule, sets up standard maintenance procedure, and provides on-line technical supports to mechanics. As for MRO scheduling, the MRO server will choose the appropriate parts for some standard MRO procedure based on information of the production and expiration date. After the schedule is arranged, the sequence of usage is also set up according to the standard MRO procedure. For example, if the part of Tag_ID¹ needs to be replaced first and parts of Tag_ID² and Tag_ID³ should be installed simultaneously later according to standard maintenance procedure. Then the MRO server will monitor if the parts are used based on this sequence by using RFID reader.

III. 3 During MRO Process

As Figure 6 illustrates, the mechanics carry the mobile device, like smart phone, PDA, or notebook during MRO process. The mobile device can communicate with MRO server wirelessly by using 802.11. It is also equipped with a RFID reader to read tag information. Before the mechanics start working, the mobile device downloads the MRO schedule. Besides, the mobile device also downloads the assembly instruction from MRO server. When the mechanics begin performing MRO process, he or she scans the parts based on the sequence of usage. Meanwhile, the mobile device will compare the scanning sequence of tags with predefined assembly order, which is stored in device. If the

comparison result is not correct, the mobile device informs the mechanics that some parts are missed or the assembly sequence is wrong. This action will make sure: (1) all parts are used according to the planned schedule and designed sequence. (2) no part is missed.

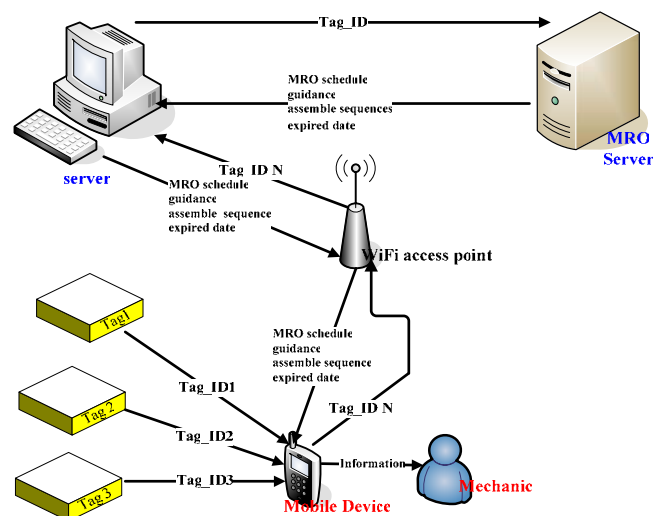


Figure 6 Process of Using Mobile Device to Run MRO

III. 4 Inspection

After the MRO is finished, the aircraft must be inspected before taking off. An inspector will do so by reading tags and checking MRO schedule and sequence with mobile device. If everything is O.K., the inspector uses mobile device to generate the e-document of “Aircraft Certification of Release to Service & Maintenance Statement”, and e-signs this statement. Then this electronic document will be sent to the database of authority along with the corresponding digital signature.

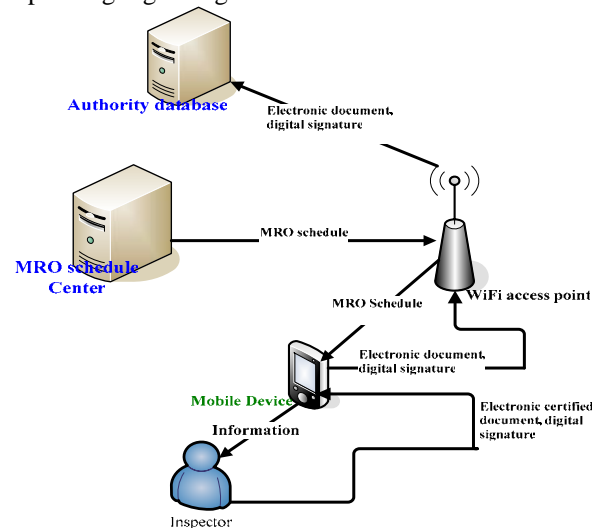


Figure 7 Process of Storing e-Document and Issuing Digital Signature

IV. Conclusions and Future Works

We believe that this architecture has the following benefits:

(1) Prevent Fake Parts: In this architecture, a tag will store MAC data for self-authentication and the secret key is only kept by manufacturer. This enhances the ability of fake-resistance.

(2) Decline Man-made Error: The maintenance schedule and sequence is stored in MRO server. When the mechanic performs MRO process, it is easy for him/her to check whether he/she uses the assigned parts and follows the predefined assembly sequence. It can decrease or eliminate human errors that may occur during MRO.

(3) Fast and Credible Inspection: The inspector issues electronic document of "Aircraft Certification of Release to Service & Maintenance Statement" with digital signature after completing the inspection. It provides an effective and efficient certification approach.

In conclusion, this architecture not only can be deployed into MRO process of aviation industry, but also is extended to other areas such as vehicle industry or delicate apparatus assembly line, in which the procedure accuracy is a critical concern.

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Outbound Delivery Using RFID in Sap System

Sheng Wang, Dong Wang
Class B0303395
School of Software
Shanghai Jiao Tong University
Shanghai, China
800 Dong Chuan Road
Phone: 086-021-62933040; 086-13764599933
email: ion214@sjtu.edu.cn

Abstract: Wang Sheng is a developer for the RFID solution; he is interested in RFID middleware and SAP RFID solutions. He is a master student at Shanghai Jiao Tong University. From Sep.2004—Jan. 2005, he is working a RFID Demo center project in Shanghai, and this article is about a Outbound Delivery process in SAP system with RFID technology. Wang Dong is professor at Shanghai Jiao Tong University. His area of expertise is logistics solution and RFID technology. This paper will tell you how RFID make magic in outbound delivery process.

Keywords: SAP: SAP is the biggest business software provider in the world.

R/3: SAP R/3 is an ERP software powered by SAP. It is the core software of all SAP systems. SAP R/3 a great brand in ERP.

RFID: Stand for Radio Frequency Identification, a technology similar in theory to bar code identification. With RFID, the electromagnetic of electrostatic in the RF portion

of the electromagnetic spectrum is used to transmit signals. An RFID system consists of an antenna and a transceiver, which read the radio frequency and transfers the information to a processing device, and a transponder, or tag, which is and integrated circuit containing the RF circuitry and information to be transmitted.

Software and Hardware are used in the whole process.

Software: SAP R/3, CIP (Collaboration Inventory portal, a RFID Middleware), RFID Device Control

Hardware: SAP R/3 server (CPU P4 3.0*4; Memory 4G), CIP Server (CPU P4 3.0 memory 512M), RFID Reader (Alien RFID Reader), RFID tags (Class0 tag).

Outbound delivery process

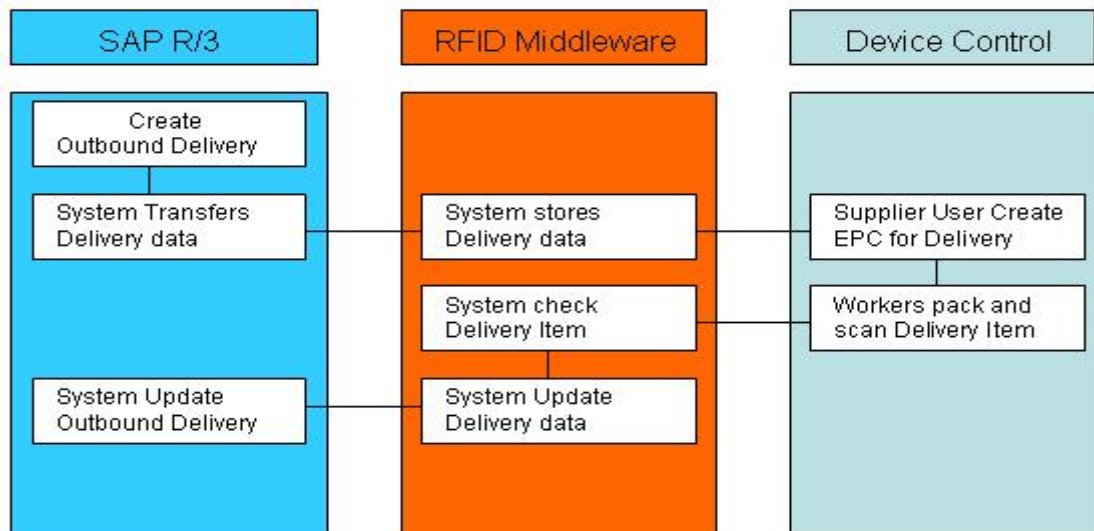
The physical view of RFID-enabled outbound delivery is like the picture.



RFID-enabled Outbound Delivery

We first paste the RFID tag to cases and pallet. This process is called “tag commission”. When the tags are print to the cases and pallet, Hierarchy of this mapping is record in the RFID middleware system. This is the process of “packing” in RFID solution. And packed goods are send out

through RFID-installed Gate, the RFID reader is mostly fixed Readers, and check out can be automatically. The third section we call this “loading”, the goods with RFID tags are loaded to the trucks and the mapping of this good issue is also recorded in both the RFID middleware and R/3 systems.



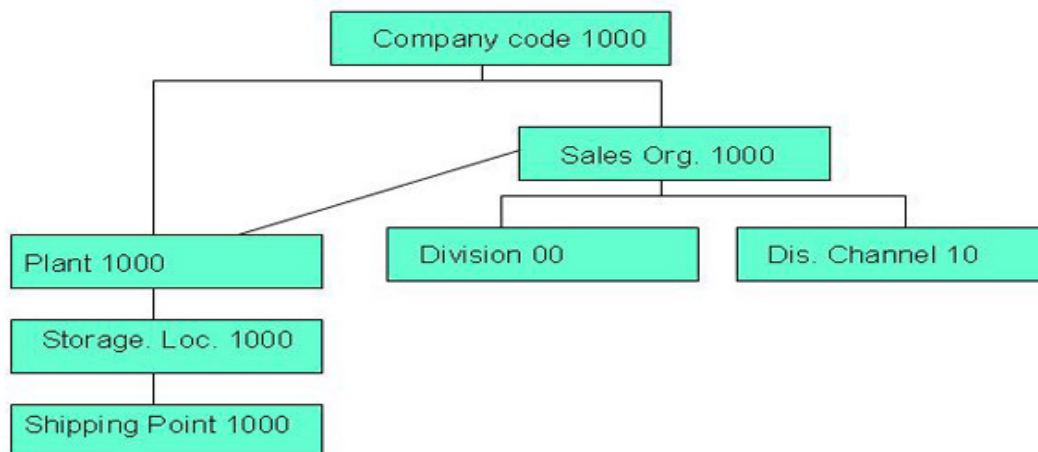
- 1) First we create a outbound delivery in SAP R/3 system, in the system we use transaction code"VL01n", and When the outbound delivery is created in SAP system, the delivery data is transfer to RFID Middleware systems automatically (a SAP technology call "BADI" is used here, it will be talked later).
- 2) The information about the EPC data are send to Device Control through XML, and Supplier user can doing tag commission.
- 3) After the tags are print to the cases and pallet, the workers pack them together. Then workers pushed the barrow though the RFID Gate.
- 4) The system gets the information from the RFID Reader installed in the Gate, then the system check the mapping of the cases and pallets with the original information stored in the system.
- 5) When the checking is OK, the RFID middleware update the delivery. And the information is transferred to system
- 6) R/3 system also updates the delivery data by BAPI calls.

Master Data Management

Master Data in SAP

There are information about Company, Plant, storage location and Material, and this information is saved the in R/3 system by customizing job.

A company with plant 1000 and sales organization 1000 is customized in SAP R/3 system. This company is a vender that will perform outbound delivery in our Scenario. The company's organization is show below.



Master Data in RFID Middleware

RFID Middleware contains information about RFID tag, RFID object, tag observation, Material and EPC mapping.

Table: STATUS

item	type	length	NULL	Prime Key	Default value
id	integer	4	NO	YES	
statusMessage	char	100	NO	NO	
timestamp	timestamp	10	NO	NO	

Table: READERID_XXX (observation table of one Reader XXX)

Item	type	length	Null	Prime Key	Default value
id	integer	4	NO	YES	
epc	char	16	NO	NO	
timestamp	timestamp	10	NO	NO	

Table: Material (Material with EPC prefix)

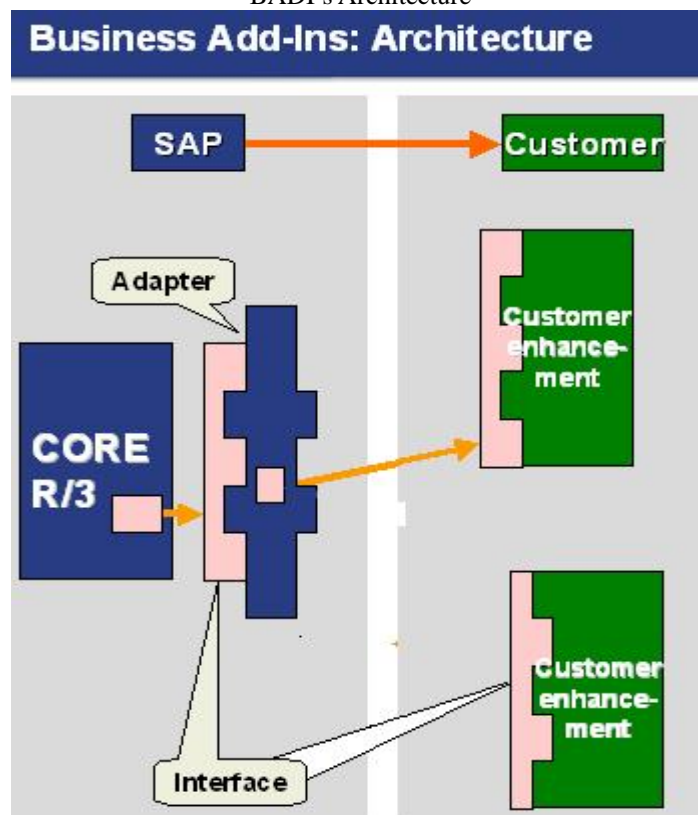
Item	type	length	Null	Prime Key	Default value
id	integer	4	NO	YES	
Material	char	16	NO	NO	
EPC prefix	char	16	NO	NO	

Interface programming

To fit this requirement, SAP BADI interface technology is been used here.

Requirement 1: Delivery transport to Middleware system automatically

BADI's Architecture



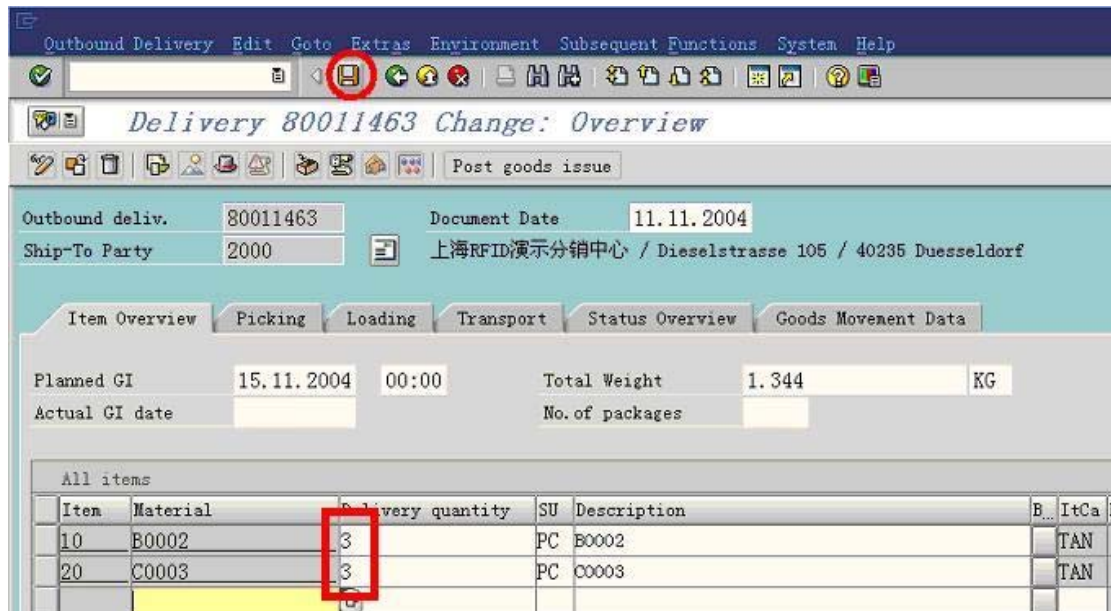
BADI (Business Add-In) is an Enhancement technology to provide connectivity to R/3 system. With BADI, SAP customer can change their software process easily and with good SAP support.

Enhancements are made possible by SAP application programs. This requires at least one interface and an adapter

class that implements it. The interface is implemented by the user.

Our Delivery process with BADI

1) When first Create or Change a delivery



2) Implement the delivery interface The method `publish_after_save` is called by the system "if_ex_delivery_publish".

```
method if_ex_delivery_publish~publish_after_save .
    data: ltab_liklips type table of zstrc_liklips initial size 0 ,
          lwa_liklips type zstrc_liklips,
          lwa_liklips_tmp type zstrc_liklips.
    .....
    .....

    call function 'Z_RFID_SYNCDOTOCIP' destination 'JCO'
        exporting
            reqtext          = '0000000000'
            tables
                z_liklips     = ltab_liklips
        exceptions
            communication_failure = 1 message msg_text
            system_failure       = 2 message msg_text.
    .....
    .....
endmethod.
```

3) Function 'Z_RFID_SYNCDOTOCIP' transfers the delivery data to RFID Middleware.

Requirement 2: Post Good issue creates material back to SAP system.

BAPI (Business Application Program Interfaces) is

defined as a method of an SAP Business Objects. SAP BAPI Interface. The BAPIs in the R/3 System are currently implemented as function modules all of which are created and managed in the Function Builder. Each function module underlying a BAPI:

- 1) Supports the Remote Function Call (RFC) protocol
- 2) Has been assigned as a method to an SAP Business

Object in the Business Object Repository

3) Is processed without returning any screen dialogs to the calling application

Our post Good issue with BAPI

1) RFID Middleware (CIP System) post goods

Collaboration Inventory Portal

请选择管理地点:
ShangHaiNo1 提交

Supplier View

- Delivery Process
 - Create Delivery
 - Delivery Overview
 - Create ASN From Delivery
 - ASN Overview
 - Shipping By ASN
 - In Road SN
- Alert Monitor
- Inventory Monitor
- Release Process
- ASN Maintenance
- Supplier Plans
- Supplier Plans
- Goods Return View
- Customer View
- MasterData

Expand All - Collapse All

ASN(供应商视图)

查找ASN

搜索

客户代号: 产品编号:
 运输起始地点: 订单号:

发货处理(供应商视图)

发货

BusinessNo :	客户代号:	默认发货仓库:	发货日期
0080011481	NingBoNo1	ShangHaiNo1	2004-11-1

发货清单

货物ID	发货目的仓库
A0001	NingBoNo1
B0002	NingBoNo1
C0003	NingBoNo1
D0004	NingBoNo1

打包 取消

2) When post goods issue at RFID Middleware, it calls

BAPI “z_postdoforsap” to post goods issue in SAP system.

```
function z_postdoforsap.
*-----
* Local interface:
* IMPORTING
*   VALUE(I_VBELN) LIKE LIKP-VBELN OPTIONAL
* EXPORTING
*   VALUE(RETURN) LIKE BAPIRET2 STRUCTURE BAPIRET2
*-----
.....
perform import_data using i_vbeln return.
.....
endfunction.
```

3) Delivery status in SAP is automatically change by this way

The screenshot shows the SAP Document Flow interface. At the top, there is a menu bar with 'Document flow', 'Edit', 'Goto', 'Environment', 'System', and 'Help'. Below the menu is a toolbar with various icons. The main area is titled 'Document Flow' and contains a sub-menu with 'Status overview', 'Display document', 'Service documents', and 'Additional links'. The document details are as follows:

Delivery	80011463	
Business partner	2000	上海RFID演示分销中心

Doc.	Date	Overall Processing Stat
. Standard Order 8208	11.11.04	Being processed
Delivery 80011463	11.11.04	Being processed
. GD goods issue:delvy 4900026813	11.11.04	complete

Benefit of RFID-enabled outbound delivery.

Wal-Mart ask his vendors to do outbound delivery with RFID-enabled. And at January 2005, 132 Wal-Mart's vendor (32 voluntary vendors) has paste RFID tag in cases and pallet. The benefits are:

- 1) When delivery information is send to Wal-Mart, they can receive the goods automatically, because RFID Readers can scan RFID tag in a long distance. Here we need an Event Management in Wal-Mart side to handle the deliveries.
- 2) With RFID technology, the cases and pallets can be easily managed and reused.
- 3) At the vendor side, post goods issue can be check by RFID instead of by workers.
- 4) Goods information can be traced at every point of the delivery.

In a word, RFID-enable outbound delivery increases the efficiency of the whole Supply Chain Process.

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RFID Technology Enhancing Supply Chain Competence and E-Business: An Opportunity or a Threat?

Guilin Wang¹, Elsie S. K. Chan²

¹ Newcastle Business School
Northumbria University, United Kingdom
gui.wang@unn.ac.uk

² School of Business and Informatics
Australian Catholic University
Melbourne, Australia
Tele. +613 9953 3162
Fax. +613 9953 3775
elsie.chan@acu.edu.au

Abstract: Radio Frequency Identification (RFID), which uses radio waves to identify objects, was discovered in 1930s for military purposes and it transformed into commercial uses in 1980s in the United States. In this paper, we explore the research domains in RFID technology, innovation and diffusion theory, and supply chain management within the existing literature for exploring whether RFID enhances supply chain competence and e-business. This paper also forms a preliminary study base for researchers who may wish to carry on future research in this area.

Keywords: Emerging Technologies, RFID, supply chain.

I. Introduction

Radio Frequency Identification (RFID) is a term for technologies that makes use of radio waves to automatically identify people or objects [48], [25]. It was discovered in 1935 by Scottish physicist Sir Robert Alexander Watson-Watt [36] mainly for military use. It only started to become popular in commercial sector around 1980s, particular in automobile industry such as Ford, GM, Chrysler, and Toyota, with the RFID tags produced by Allen-Bradley in 1984 [45]. In this paper, we explore whether RFID would enhance the supply chain management system, and, whether it is an opportunity or a threat. We explored a number of different research domains (including RFID technology, supply chain management and diffusion theory) within the existing literature. According to Bourner (1996), there are a number of good reasons for spending time and effort on a review of the literature. Some of these reasons taken for this paper are: *to increase breadth of knowledge within a subject area*, and *to provide the intellectual context for one's own work, enabling the positioning of a project relative to other work* [10]. Hence, we organize this paper into seven sections. In the next section, it brings forth RFID fundamentals including the characteristics of RFID and a comparison

between RFID and bar coding. In Section 3, we discuss how RFID technology fits in with the Theory of Technological Innovation Diffusion. In Section 4, we present how RFID improves the supply chain management and e-Business. In Section 5, we cover the current applications of RFID in Asia, particularly in China. In Section 6, the disadvantages and problems of RFID will be outlined. The conclusions and the future research areas of RFID in supply chain management will be presented in the final section.

II. RFID Fundamentals

II.1 The Development and Characteristics of RFID

RFID is a wireless tracking technology that allows a reader to activate a transponder on a radio frequency tag attached to, or embedded in, an item, allowing the reader to remotely read and/or write data to the RFID tag [48], [25]. RFID utilizes a semiconductor (microchip) in a tag or label to store data. Data is transmitted from, or written to the tag or label, when it is exposed to radio waves of the correct frequency and with the correct communications protocols from an RFID reader. Tags can be either *active* (using a battery to broadcast a locating signal) or *passive* (using power from the RFID reader for location). Because the tag sends an electronic signal, it can transmit information when buried under several layers of products and shipping material, through concrete walls or even under water [6].

RFID has its roots dating back to WWII when British planes had surface mounted transponders installed so that radar could detect their planes from those belonging to the enemy [8]. After the 1950s, development went a little quiet until the 1960s when in the first commercial use of RFID, electronic article surveillance was used to counter theft. In the 1970s, inventors, companies, academic institutions and government all continued developing RFID applications and the opportunities afforded by the technology began to be realized. The latest generation of RFID allows the dozens of individual objects within a group to be uniquely identified at

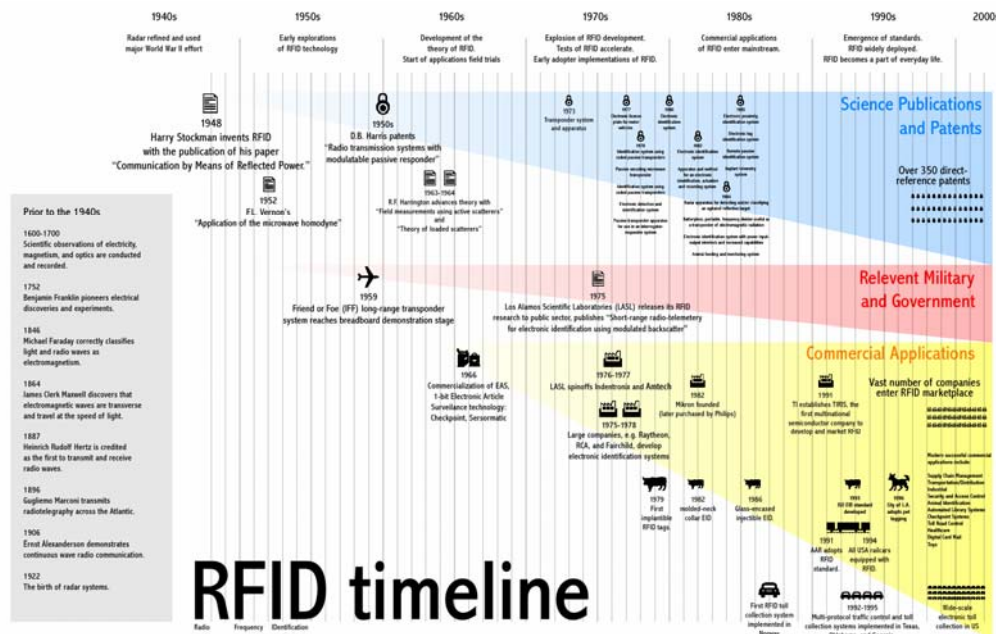


FIGURE 1. RFID Timeline
(Source: Interaction Design Institute Ivrea 2002 [24])

	Bar Coding	RFID
Reading capability	Optical-line of sight required.	Wireless – line of sight not necessary (some environmental exceptions).
Reading speed	Bar coding can read a single label per scan.	RFID can read multiple tags in a single pass.
Durability	Labels tend to be damaged in harsh processes. Etching directly onto part has increased durability.	Tags are more durable than bar code labels, can be used during and after most harsh environments.
Amount of information	A 1D bar code can store 20 alphanumeric characters, while a 2D bar code can store roughly 2,000 characters.	RFID tags are capable of storing several thousand characters, or several kilobytes, of information.
Flexibility of information	To update information, a bar code label must be replaced with a new bar code label.	To update information, many RFID tags can have their memories updated with new information through wireless communication.
Security	2D bar codes provide encryption capability.	RFID tags have manufacturer installed identification codes that cannot be changed, thus making counterfeiting difficult.
Cost per label or tag	Bar code labels typically cost less than \$0.01.	RFID tags cost from \$0.25-\$0.50, up to \$250.
Standards	Bar coding is standardized and widely accepted.	RFID lacks complete standardization, especially in the global environment
State of infrastructure	The infrastructure to support bar codes is in wide existence.	The infrastructure to support RFID is minimal. Users would have to invest in additional equipment to support RFID.

TABLE 1. Summary of Differences between Bar Coding and RFID
(Source: Robert W. Baird & Co. Incorporated 2004 [38])

the same time. However, until recently, RFID, which allows the tracking of individual items, has not been feasible for

many commercial applications given its high cost and technological limits. Today, companies such as Alien

Technology and Matrices are developing RFID components (e.g., tags, readers, etc.) at a much lower cost than was formerly possible, creating a wider opportunity for RFID. Figure 1 gives the timeline of RFID [24].

II.2. RFID Attributes – A Comparison vs Bar coding

As bar coding is the most established automatic identification technology and RFID can be considered the most promising. Conceptually, bar coding and RFID are similar: both are intended to provide rapid and reliable item identification and tracking information. RFID is similar in theory to bar code identification systems. Both technologies establish object identification via scanning and facilitate data collection. However, RFID offers vast improvements over bar coding. The advantages of RFID over bar code technology are summarized in Table 1.

RFID technology is “essentially a new and vastly improved barcode [33].” It has been considered a replacement for barcodes. However, it is much more than an “improved barcode,” not only because it does have high storage capacity and ability for reprogramming, but also because of its miniature size and the accompanying tracking ability. We evaluate their suitability in the different application types.

Authentication applications

RFID technology is far more suitable than bar coding for authentication type applications due to the relative ease of copying and forging bar codes. In contrast, RFID technology is considered to be almost impossible to counterfeit or copy, which makes it a valid technology for authentication purposes.

Tracking applications

In most tracking applications, bar codes will currently provide the best payback for investment. It helps to alleviate the problems of manual data handling with relatively low costs [19]. The installed base of bar code readers is extensive, as it is by far the most popular automatic identification technology [18]. However, if the deliveries are likely to require excessive handling and poor environmental conditions, RFID is a viable option as the identification technology [11] [26] [31]. The use of RFID greatly increases the needed investments, and thus easily reduces the number of tracking points in the system, as even the cheapest RFID readers with limited functionality cost around one thousand Euro [47].

Process effectiveness applications

At the moment bar code based applications are widely used in the short shelf life supply chain. Bar code scanning reduces errors associated with manual data handling, and produces visibility to aid supply chain management [19]. Also, the introduction of new bar coding standards that

enable adding the sell-by dates to the codes have helped in retaining the integrity of stock rotation and hence help solve the spoilage problem [43]. However, there are problems associated with bar code data collection. The reading of bar codes invariably requires manual handling in the supply chain. Either the packages with bar codes or the reading devices are handled manually in order to read the codes [11] [13] [26] [31]. This makes data capture difficult, especially in the retail store environment where large amounts of goods are handled in facilities not designed for effective logistics [17]. Readability of bar codes is, occasionally, problematic due to dirt and bending; resulting in reduced accuracy of reading rates, particularly in successive handling situations and in difficult environments [35] [31]. However, RFID tags with sensor functions can monitor physical conditions, like temperature and humidity and to register if the product has suffered any knocks. The greatest cost efficiency can be achieved with recyclable transport containers, as the same investments in transponders can be continuously utilized [2].

Information management applications

Currently, in license plate applications bar coding is the most cost efficient technology. When storing read-only information directly on the identifiers, two-dimensional bar codes are often the best alternative due to the amount of information that can be incorporated and the relatively low price. In applications with requirements for read-write capabilities RFID is, of course, preferable.

Even though there are differences between bar code and RFID standards, technology can overcome this and now some stand-alone devices can read from barcode and write to RFID tags [23][7].

III. Theory of Technological Innovation Diffusion

III.1 RFID and e-Technology

The use of e-technology as a means to enhance supply chain competence has been widely espoused. A brief listing of these technologies ranges from those that have existed for decades to some very recent innovations, and encompasses many of the following:

- the personal computer;
- electronic data interchange (EDI) among carriers, shippers and customers;
- bar-coding and scanning;
- advance ship notices (ASNs);
- shipment and package tracking systems;
- satellite global positioning systems (GPS) and geographic information systems (GIS);
- software agents, HTML, JAVA, XML, object-oriented programming and semantic webs;
- the Internet, intranets and extranets;

- Web-enabled relational databases, data warehouses and data marts;
- decision support systems;
- electronic signature technology;
- wireless technology; and
- Enterprise Resource Planning systems (ERP).

Application Technology	Authentication	Tracking	Automation	Information Management
Bar code		X	X	X
RFID	X	X	X	X
OCR			X	
Biometrics	X			
Vision recognition			X	
Magnetic ink	X		(X)	
Smart cards	X			X
Contact memory			(X)	X
Magnetic stripe	X			X
Bluetooth	(X)	(X)	(X)	(X)
GPS		X		
GSM cell location		X		

TABLE 2. Different Identification Technologies Classified By Application Types
(Source: Kärkkäinen, Ala-Risk and Kiianlinna 2001 [27])

Various technologies used to track and automatically identify (ID) people, products, and other objects in order to enhance the supply chain management are:

- Barcodes
- Optical Character Recognition (OCR) Systems
- Biometrics
- Voice recognition and ID systems
- Fingerprint ID systems
- Smart cards
- Memory cards
- Microprocessor cards

RFID combines features of several of these technologies. Like barcodes, RFID is used to identify and track objects. As with OCR and biometrics, RFID enables automatic ID and verification. RFID also can be used like smart cards, memory card, and microprocessor cards to store information and provide interactive data processing.

The most important strength of RFID technology is that when using RFID tags, no line of sight is needed with the identifier in order to identify the object. Products can be identified effortlessly, during processing and without additional handling. Tags can be read through non-metallic materials, and about 60 tags can be read simultaneously [11] [26]. Also, most RFID tags are durable and resistant to temperature and other environmental factors [15]. More detailed descriptions of the technologies can be found in Table 2 [27].

III.2 Rogers' Technological Innovation Diffusion Theory

Rogers (1983) explains *diffusion* as: the process by which an innovation is communicated through certain communication channels over time among the members of a social system [40]. He breaks the adoption process down into five stages:

awareness, interest, evaluation, trial, and adoption. The distribution of adopters of an innovation can be approximated by a normal distribution of the time of adoption. Using the mean and standard deviation of this distribution as a method of segmentation results in five adopter categories: (1) innovators, (2) early adopters, (3) early majority, (4) late majority, and (5) laggards [40] [41].

- (1) *Innovators* are the first 2.5 percent of the individuals in a system to adopt an innovation. While an innovator may not be respected by the other members of a social system, the innovator plays a gate keeping role in the flow of new ideas into a system.
- (2) *Early Adopters* are the next 13.5 percent of the individuals in a system to adopt an innovation. The early adopter decreases uncertainty about a new idea by adopting it, and then conveying a subjective evaluation of the innovation to near-peers through interpersonal networks.
- (3) *Early Majority* is the next 34 percent of the individuals in a system to adopt an innovation. The early majority follow with deliberate willingness in adopting innovations, but seldom lead.
- (4) *Late Majority* is the next 34 percent of the individuals in a system to adopt an innovation. The late majority adopt new ideas just after the average member of a system.
- (5) *Laggards* are the last 16 percent of the individuals in a system to adopt an innovation. Laggards tend to be suspicious of innovations and change agents. From the laggard's viewpoint, their resources are limited and they must be certain that a new idea will not fail before they can adopt [39].

III.3 Applications of Rogers' Theory in RFID

The RFID industry is still at the growing stage. Technical standards and customer demand will hasten maturity of the industry, favourably impacting supply capacity and cost. Some actual implementations of RFID technology are being experienced within some organizations in the U.S. and Europe. Wal-Mart, for example, the world's largest retailer, has instructed its top 100 suppliers to place RFID tags on all its pallets and cases, though not on individual items, by January 2005. Over the next decade, it is likely that nearly every Fortune 500 and Global 1000 company will join the U.S. Department of Defense (DoD) and Wal-Mart in employing so-called automatic identification technology, making RFID an essential factor in almost any business [33].

Royal Philips Electronics and IBM have announced a major collaboration, which will see the joint development of RFID and smart card applications. The two companies hope that their combined reputation and market muscle will attract customers seeking to roll out their RFID projects using well-established suppliers [4].

Woolworths involvement with RFID technology came under the Home Office's 'Chipping of Goods' initiative [20].

Tesco is currently trialing tags on DVDs at its Sandhurst and Leicester stores. In this trial Tesco is testing smart shelf technology in collaboration with MeadWestvaco, an American packaging company and Entertainment UK (EUK), that keeps DVDs stocked in 2,500 retail stores in the UK [46].

In January 2003, Gillette became the first major manufacturer of consumer goods to place a giant order, 500 million, for RFID tags.

In U.K., Argos' involvement in the 'Chipping of Goods' initiative is mainly due to the fact that they are a retailer of high value products such as jewellery, electrical equipment and furniture. Since jewellery pieces are small and easy to convey, this was the chosen product to track for this nine-month trial, which aimed to reduce shrinkage. Up to 16 per cent of the products are returned and so an improvement in supply chain transparency was also sought [22].

Organizers of the 2006 football World Cup in Germany are to issue paper tickets incorporating smart tags. With more than 3.2 million tickets expected to be issued it will be the largest deployment so far of RFID technology at a sporting event [4].

The organizations cited above are the *Innovators* of applications in RFID, and meanwhile, the number of organizations preferred to be *Early Adopters* is increasing. Rogers identifies several additional characteristics dominant in the *Innovator* type:

- venturesome, desire for the rash, the daring, and the risky,
- control of substantial financial resources to absorb possible loss from an unprofitable innovation,
- the ability to understand and apply complex technical knowledge, and
- the ability to cope with a high degree of uncertainty about an innovation.

Early adopters frequently serve as opinion leaders who can persuade others to adopt the innovation by providing evaluative information [41]. From the perspective of theory development, knowledge about the characteristics of early adopters can help researchers develop richer theoretical models that explain adoption behaviours across a range of adopter types.

Recently statistics indicate that more than four-fifths of U.S. businesses plan to use the tracking technology at some point, with 69 percent looking at RFID as in 2005 [9]. This shows that U.S. companies adopt RFID technology at *Early Majority* category.

IV. RFID Emerging Applications—Supply Chain

IV.1 Supply Chain Historical Perspective

RFID technology can help suppliers eliminate delivery lag times, determine point of origin, track orders in the supply chain, and make inventories more visible (e.g., in a warehouse, in a shopping cart, on a battlefield). Technically, RFID has the capability to increase efficiencies in supply operations by minimizing the need for line-of-sight proximity between a scanner and an RFID tag. In fact, industry analysts are predicting that within a decade, RFID technology will have matured to a point where loaded shopping carts can be automatically read as a customer moves through the store checkout, without the need to unload or manually read tags.

According to Accenture (2004), a global management consulting, technology services and outsourcing company, an RFID open systems solution can increase inventory turns by 10 to 15 percent. Greater inventory turns facilitate capital resource optimization, increased margin procurement and significant reductions in obsolete inventory levels. Supply chain managers today must be better informed with accurate real-time data to stay competitive [1]. Other potential benefits of RFID technology in the supply chain management are listed in Table 3 [6].

Explanation of P, C, I symbols: Tagging at various packaging levels (Pallet, Case, Item) in order of significance to achieve named benefits.					
Function / Activity	Potential Benefits	Manufacturing	Warehousing	Transportation	Store Operations
Demand Planning	Reduced out of stocks	C	C, P	PC	C, I
	Decreased order lead time	C	C, P	PC	C, I
	Sales driven replenishment	C	C, P	PC	C, I
	Increased inventory turns	C	C, P	PC	C
Item/Batch/Lot Tracking	Decreased safety stock	C	C, P	PC	C
	Reduced sale of counterfeits	C, I	C, P, I	P, C, I	LC
	Increased contract compliance	C	C, P	PC	C
	Increased product quality	C, I	C, P	PC	C
Security	Reduce theft	C, I	C, P, I	P, C, I	LC
	Reduce chances for product tampering	C, I	C, P, I	P, C, I	LC
Procurement & Material Storage	Reduced order lead time	C, I			
	Increased raw material availability	C, I			
	Higher capacity utilization	C, I			
Production	Higher capacity utilization	C, I			
	Reduced order cycle time	C, I			
	Increased quality	C, I			
Receiving	Decreased unloading times		PC		PC
	Increased accuracy of accepted shipments		PC		PC
Order Selection	Increased accuracy of orders		C, I, P		
	Increased order fill rate		C, I, P		
Exception Product Location	Fewer misplaced items		C, P, I		
	Decreased time to locate specific items		C, P, I		
Loss Prevention	Reduced shrink		C, P, I		LC
Asset Management	Increased productivity of assets			PC	
	Reduced loss of assets			P	
	Pricing based on actual use of assets			P	
Yard Management	Increased productivity of assets			P	
	Increased visibility of drop shipments			P	
Contract Compliance	Decreased exceptions management			PC	
	Increased customer satisfaction			PC	
Routing	Dynamic routing			PC	
Checkout	Increased accuracy of checkout				LC
	Increased checker productivity				LC
Returns and Reverse Logistics	Increased accuracy of returns acceptance				LC
	Increased accuracy of refund amounts				LC
	More efficient recycling or disposal				LC
Post-Sales Service	Increased warranty compliance				LC
	Faster warranty and repairs processing				LC

TABLE 3. RFID and the Supply Chain
(Source: [51])

IV.2 Driving Forces of RFID Applications in Supply Chain Management

RFID Technology and Information Flow

The supply chain is the flow of both information and material through a manufacturing company, from the supplier to the customer. Information flow broadcasts demand from the end customer to preceding organizations in the network. Information has to be accurate, timely and visible before it can replace inventory. It is the integration of transportation, distribution, ordering, and production. The information can access data interchange and data acquisition at the point of origin and point of sale through inter-company and intra-company. The smoother the information flow, the earlier information can be reached to the customers. It is important that systems be designed to enhance open and rapid communication and sharing of information across the supply chain and within the organization. The flow of information has been recognized alongside the importance of materials flows in the logistics channel. Information technology has been forwarded as a means of achieving competitive advantage, and as a valuable tool used to ensure that the logistics objective of providing target services at the least total cost is accomplished.

RFID enables the user to find, track, secure, and count items faster and with higher accuracy than with other competing technologies. RFID can dramatically increase the

speed, efficiency, and accuracy of data collection by improving the linkage between management information systems directly to the various data points of the supply chain. This capability allows information to be collected, processed, shared and leveraged on a near real-time basis by virtually all members of a supply chain. It is believed that this increased communications speed will continue to enhance the management capabilities throughout the supply chain as they are adopted further. Figure 2 indicates the large number of touch points in a supply chain where RFID tagged pallets, cases and items aid in connecting the physical world with the information world. This does not just only apply to traditional distributions, i.e. from manufacturers to retailers. It can also adapt to the B2B e-business/e-commerce.

RFID is a means of capturing data about an object without the need of a human to read and recode the data. Radio frequency (RF) tracking is a current and highly beneficial technological advance that could lead to tremendous cost reduction in the future for all retailers. If the reader detects a large quantity of a certain product moving off the shelf, it automatically sends a signal to a nearby camera to take pictures and alert security to make sure that these items are not being stolen. This type of information should help stores reduce the amount of theft by not only the customers but also its employees.

Issue Pertaining to Process and Quality Control

RFID enables a number of process management and quality control innovations through real-time tracking.

Inventory expiration management

Products can be tagged for expedited processing when there are time-sensitive constraints. The technology is typically used to track assets at three levels — pallet, case/carton, and unit. Tagging at all three levels allows each to possess its own identity or to be associated with the others for tracking at various stages in the supply chain. With the associations made possible by RFID, when a pallet passes by a reader, for example, the RFID system can identify the pallet and check its location into the software system, while at the same time recognizing the corresponding cartons and units that it is carrying.

RFID's faster scanning process significantly increases inventory visibility, which enables better inventory management through more efficient staging and rapid cross docking. Improved inventory management increases inventory velocity and allows for incremental labor cost reductions. Further, as a result of the enhanced tracking, less safety stock is required.

Manufacturers can continuously track products offering verification and certification of product location, product handling, environmental conditions and processing procedures. And meanwhile, tracking a product's location, handling procedures, environmental conditions, and processing will enable quality control, improvement, and certification.

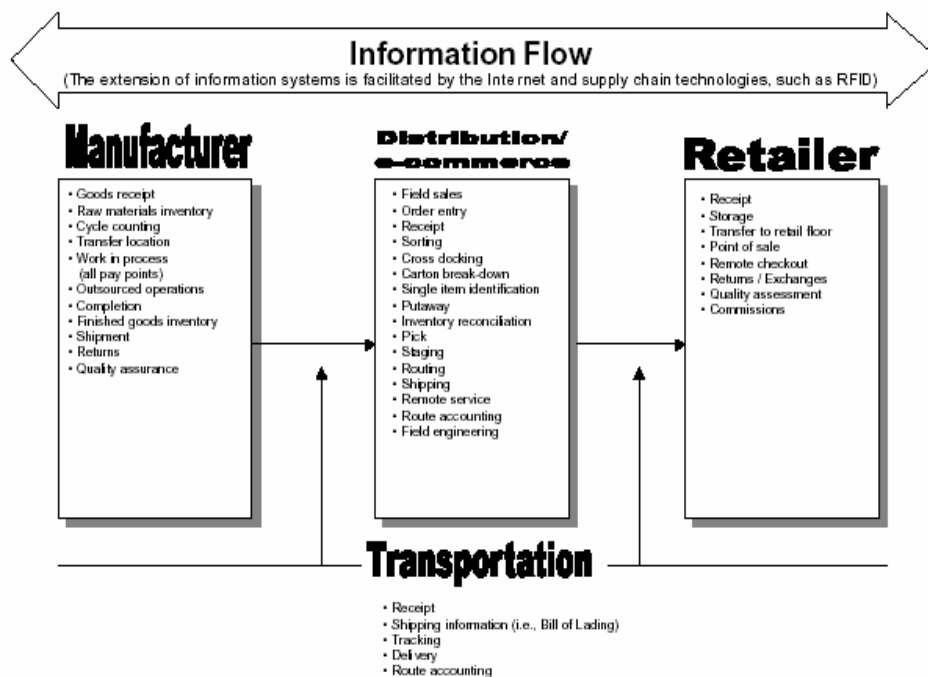


FIGURE 2. Potential RFID Touch-Points in the Supply Chain
(Source: Robert W. Baird & Co 2004 [38])

Employee management and monitoring

Quality improvement requires that line personnel improve product handling and processing. If products can be tracked through the production process, then personnel who handle the products can be better managed and supervised.

The increased reading capability reduces the need for manual intervention as RFID readers can automatically scan incoming shipments entering a distribution center or retail location. RFID's more robust scanning capability also reduces labor associated with pallet breakdown and cross docking activities. In addition, improved inventory accuracy also reduces the need for labor intensive physical counts.

Just in time manufacturing and delivery

Manufacturers can use RFID to work more closely with suppliers and customers to integrate production activities within the plant and to streamline interactions with other participants in the supply chain.

As supply chain members receive better, faster and more accurate inventory information, they improve their forecasting and plan their operations more effectively. As a result, retailers have fewer stock outs, resulting in improved sales (retail sales are said to be reduced by nearly 4% each year from stock outs), while distribution centers save through increased shipping accuracy, which lowers returns and improves customer satisfaction.

Government Regulations and Certifications

Governments can play an important role in helping to foster the adoption of new technologies such as RFID. For example, in the U.S., Department of Defense (DoD) is seeking to use RFID to transform its supply chain. Department of Homeland Security is looking at RFID to secure the nation's ports and borders. Food & Drug Administration (FDA) is encouraging pharmaceutical companies to use RFID to reduce counterfeiting and secure the country's drug supply. Government concerns over food safety have increased dramatically and they are demanding improved supply chain visibility to increase safety and efficiency. This track will have experts to talk about various Government Regulations and how plants can maintain the integrity of their brands, control product from harm, better manage product recalls, comply with government regulations and gain supply chain efficiencies using RFID. For example, in European Community (EC) 178, Article 18 [16] is, the law of traceability, "The traceability of food, feed, food-producing animals, and any other substance intended to be, or expected to be, incorporated into a food or feed shall be established at all stages of production, processing and distribution."

Governments that fund RFID projects give local companies an edge while helping to promote technology that can benefit the society at large.

We have examined the U.S. and European government's roles on RFID. In the next section, we explore RFID in the Asia region.

V. RFID in Asia

V.1 Applications of RFID in Asia

In Asia, RFID applications primarily focus on logistics, with an emphasis on warehousing, shipping, maintenance of product quality and inventory management. Japan is currently researching two approaches to reducing the cost of chips and other Asian countries are expected to follow Japan's lead. Japan has already adopted RFID for a variety of purposes, including anti-theft devices, public transportation, and supply chain management. In their 2004 white paper on the status of information and communications in Japan, the Ministry of Internal Affairs and Communications (MIC) outlined a "u-Japan" policy to promote a "ubiquitous network society [30]."

RFID has been used in South Korea primarily for tracking livestock, public transportation fare payment, highway toll collection, and postal services. The South Korean government is supporting an RFID project at the Port of Busan. It is encouraging companies to invest in an RFID research park. It is also promoting RFID to satisfy growing demand for supply side applications in South Korea and globally in hopes of becoming a leading exporter of RFID technology. South Korean electronics firms such as

Samsung and LG are heavily involved in developing RFID technology. Nevertheless, South Korea's RFID technology is currently years behind that of Japan, Europe, and the United States.

Despite Taiwan's experience in establishing supply chain models and the government's success in promoting e-business, the adoption of RFID technologies in Taiwan has been relatively slow. The government of Taiwan is beginning to assist in the development of an RFID industry and to promote the use of RFID technologies among leading industries.

The Singapore government has put up US\$5.8 million to support the development of the RFID industry in the island republic, while the Chinese government has been encouraging the use of RFID for mass transit tickets and other applications to stimulate adoption. If history is any gauge, this government-industry partnership in Asia is likely to catapult the region to the forefront of RFID adoption.

V.2 Overview of RFID Adoption Drivers in China

China, as a key manufacturing center, will be directly affected by the RFID adoption. There are several driving forces to have RFID adopted in China. Chinese businesses began with a weak foundation in the intense world trade environment, similar to the many other companies that grew from developing countries. How were these Chinese businesses able to compete with foreign competitors armed with strong capital structures and efficient communication networks?

Firstly, as China becomes one of the world's main manufacturing centres, 'Made in China' is reshaping the world supply chain structure. Consequently, China logistics is playing a key role in world business that no manager can afford to ignore. Global manufacturers supply products to many nations, but no nation plays a bigger role than China. Well over 70 percent of the more than \$200 billion worth of goods imported into the U.S. from the Pacific Rim each year comes from China [37].

Chinese government officials and heads of Chinese companies are placing an increased emphasis on the country's logistics infrastructure, which has not kept pace with the growth in manufacturing during the past decade. Because of the growth of China's logistics infrastructure has lagged, China's supply chains are highly fragmented.

China is the world manufacturing engine and the adoption of RFID in the factories and distribution centers of China is fundamental for RFID technology to deliver on its promise of product visibility throughout the global supply chain. China is also a powerful source of out-sourced manufacturing, and suppliers of RFID components, subsystems, firmware or integration services cannot afford to ignore this marketplace of suppliers.

Secondly, the Chinese government is closely watching the adoption of RFID by overseas companies, both to understand potential customer requirements and to learn best practices. The government is also acutely aware that Wal-Mart, with its RFID mandate, imports an estimated \$12

billion to \$20 billion (roughly 10 percent to 15 percent of overall US imports from China) per year directly from China.

Finally, experts suggest RFID might help China's retailers better compete against foreign rivals. They held several conferences on RFID within a couple of years. For example, the RFID China Summit 05, on March 10, 2005, was designed to present the latest news and key end-user case studies and pilots to help China-based decision-makers answer the questions about RFID they are struggling with. Shanghai and 44 other cities already use an RFID payment system for public transportation.

V.3 Opportunities of RFID Applications in China

RFID technology increases visibility and accountability in the supply chain. RFID will allow manufacturers, retailers, and suppliers to efficiently collect, manage, distribute, and store information on inventory, business processes, and security. Everyone recognizes China as a low-cost manufacturer and a huge potential market. In early 2004, China established a working group to draft and develop national standards for RFID tag technology. Some reports indicate the group is adhering to international standards, while others suggest the group is planning to go its own way.

The Chinese government starts to realise the importance of RFID. In addition to the focus in manufacturing, China is interested in anti-counterfeit solutions using RFID especially for the liquor and tobacco industries. Estimates show that more than six hundred million bottles of liquor and two billion cartons of cigarettes are consumed annually by the Chinese population. For the popular brands of liquor and tobacco, more than half are counterfeit items. To protect these industries, the need for anti-counterfeit solutions is compelling. RFID may be one of solutions to this issue.

VI. Threats of RFID Projects in Supply Chain

VI.1. Investment and Training Costs

Presently, RFID technology is expensive and the price of RFID tags has traditionally been a significant obstacle to its widespread deployment in Supply Chain Management. Cost is a factor that may hinder the widespread utilization of radio identification tags. Tags range in price from US\$0.55 to \$55 [28]. Currently the tag reader is possible to read 75 or more tags per second, it has been remarkably difficult to design systems that can read 100% of the cases on a pallet, let alone all of the individual cartons inside a case [21].

Another cost is the large investment for RFID implementation in the large scale IT infrastructure required to support the many suppliers. The cost of acquiring, installing, and maintaining an RFID system will be a major and determining factor in the deployment of RFID in the commercial sector. There appears to be great diversity and little quantitative information in the overall costs of acquiring, installing, supporting and maintaining an RFID system. RFID system cost is composed of tags, readers, and processing and supporting information technology hardware

and software. Higher adoption rates will cause system costs to drop and encourage more RFID users. Middleware (the software that runs the operation) costs vary from US\$25,000 to several thousand dollars [44]. Many expenses will be incurred – everything from the equipment to the management educating employees – without a real sense of what the benefits can be. Many expenses will be incurred – everything from the equipment to the management educating employees – without a real sense of what the benefits can be.

The cost of simple RFID tags is likely to fall to roughly US \$0.05/unit in the next several years [42].

VI.2. Authentication and Security Issues

Authentication is a fundamental aspect of manufacturing and customer interface systems' security. Once a user account has been authenticated and can access an object, either the user rights that are assigned to the user or the permissions that are attached to the object determine the type of access granted. Therefore, authentication applications are usually applied in security critical situations, i.e. granting access rights to restricted locations or providing possibilities for accessing privileged information. Therefore security aspects are highly relevant when considering the best possible technology for authentication applications.

The impending ubiquity of RFID tags, however, also poses a potentially widespread threat to consumer privacy [29]. Most privacy and security concerns about RFID involve the use of RFID at the individual customer level, at or after the point of sale, rather than in supply and inventory tracking applications. Privacy advocates are worried that if RFID tags are placed in common items, the product may continue to be tracked even after being purchased by consumers [49].

According to Cohen (2003), recent improvements have allowed the creation of RF tags that have limited read/write capability. Once authentication protocols for read/write applications have been perfected, there will be a greater chance for creating more secure tags [14].

Jeff Woods, a Gartner research analyst who researched ongoing RFID projects for over six years foresees by 2007, at least 50% of RFID projects will fail - a lot of companies will burn through plenty of money testing the new technology [9],[34]. Reasons for failure may be due to

- many companies have unrealistic expectations on RFID
- sometimes bar codes work best
- ROI is elusive

However, Woods agrees with many industry analysts who said RFID can live up to its billing in about three to five years.

VII. Conclusions and Future Research

In this paper we have illustrated that RFID technology has relatively higher potential applications through the supply

chain procedure over the other identification technology on both the physical transport products from the manufacturers to retailers; and the B2B e-business. We also discover that RFID technology in supply chain management in the U.S. is at *Early Majority* category as suggested by Rogers' Innovation Diffusion model. Similar study in the Asia region is encouraged. The aim of this paper is to explore the opportunities and threats of the applications of RFID technology in supply chain management through the literature review of the research domains: REID technology and the supply chain management.

Asia is eventually going to take the lead in RFID innovation and adoption. In China, because the government now sees logistics infrastructure as a focal point of the country's strategic position in the global economy, it is likely that its government plays a significant role in the adoption of RFID, both in the promotion of standards and the launching of pilot programs.

As is common with emerging technologies, several challenges must be overcome for RFID to mature to its full potential: maturation of RFID technology, harmonization of standards for hardware/software, privacy and security concerns, and implementation cost barriers.

The overall success of RFID technology in the mass market mainly depends on chip prices. It is predicted that by 2006, tags will cost \$0.05/piece [12]. RFID technology is not standardised. Current industry RFID standards are largely incomplete with respect to addressing a number of technology and application issues. "Barcodes have a good fifteen years left to run, but once RFID standards are fixed, it just needs some major retailers to drive supplier adoption, and the whole thing will quickly pick up critical mass [3].

The most straightforward approach for the protection of consumer privacy is to "kill" RFID tags before they are placed in the hands of consumers. A killed tag is truly dead, and can never be re-activated.

The Chinese government is beginning to take action to leverage RFID technology to benefit the country's overall logistics infrastructure and support key customers. Hence, there is a need and great interest for the research on applying RFID technology in supply chain management and e-business in China. We look forward to seeing whether RFID will enhance supply chain competence and e-business, whether this is an opportunity or a threat, in coming years. This paper should help establish the foundation of this research.

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Applying Information Technology to Patient Safety Reporting System

Wei Lin ^a, Hung-Hsiang-Shui Liu ^b, A-Cgou Chou ^c, Hei-mei Hsu ^d

^a Feng Chia University, Taiwan. (Correspondence)

^b Yuan's General Hospital, Taiwan.

^c Shinyin Hospital, Department of Health, Executive Yuan, Taiwan.

^d Meiho Institute of Technology, Taiwan.

Address: 168, University Rd., Min-Hsiung, Chia-Yi, Taiwan, R.O.C. , misicc@mis.ccu.edu.tw

Abstract: After a nursing staff of North Town Woman & Children's Hospital made an error injection and caused one infant dead and six injured in 2002, the Taiwan government pays more attention to patient safety. Firstly, the Department of Health (DOH) established the Patient Safety Committee in February, 2003 to promote several patients' safety activities and education training. Secondly, the committee is actively planning a nationwide reporting system of patient safety to summarize the common causes of medical errors.

Most hospitals (about 70%) have not utilized information technology to construct a patient safety reporting system. The conventional reporting mechanism is to fill a paper form and circulate through out the organization. Therefore, in order to make the greater efficiency and effectiveness on a reporting system, this research develops a Patient Safety Reporting System (PSRS) used inside the hospital to solve the disadvantages of conventional reporting mechanism and enhance patient safety and medical quality.

The prototyping method was used to develop the PSRS to assure the communication between users and system designers about the actual system to be implemented. The results show that the PSRS has higher satisfaction than that of the traditional paper method. The PSRS not only save on time and man power for reporting but also improve the anonymity and security of reporting process. These advantages have a positive effect on staffs' willingness of reporting. The experience of developing this system could be used as reference for other hospitals to develop their own PSRS

Keywords : Patient Safety, Reporting System, Patient Safety Reporting System, Medical-Error, Hospitality Business & the Internet.

I. Introduction

In 1999, Institute of Medicine (IOM) pointed out the average body count of medical error is more than traffic accident which caused international attention to medical error. The Patient safety then becomes a popular topic in the medical industry recently. In order to reduce the damage of medical error, various countries established the relevant committee to deal with the issues of patient safety and medical quality in the hope to prevent and reduce medical error.

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According to Shi's research (2003), about half of medical employees have experienced medical error events and about 70% regional hospitals and psychiatric hospital in Taiwan still using paper reporting mechanism. Studies indicate several reasons that prevent employee to report errors. Therefore, how to set up an efficient and effective yet unobstructed and secure reporting mechanism to offer medical staff first to recognize causes of errors and then to learn from the mistakes and decrease medical errors is an important issue which the medical administrators should concern. This study develops a computerized Patient Safety Reporting System (PSRS) to achieve the aforementioned goals.

II. Research Methodology

This study first reviewed reporting system related research papers to obtain some ideas about design the computerized PSRS. Secondly, a case hospital was chose for implement the system. Interviewing was used to collect the users ' needs of the systems and questionnaire was used to find out their unwilling reasons to report a medical error. The questionnaire was revised from Uribe's (2002) study. Prototyping method was adopted to develop the PSRS. Finally, an evaluation questionnaire was used to compare the traditional paper reporting mechanism and the computerized PSRS from users. At the stage of system development, suggestions from experts and scholars are used in supporting the completion of system analysis and system design. The developing steps are as followed.

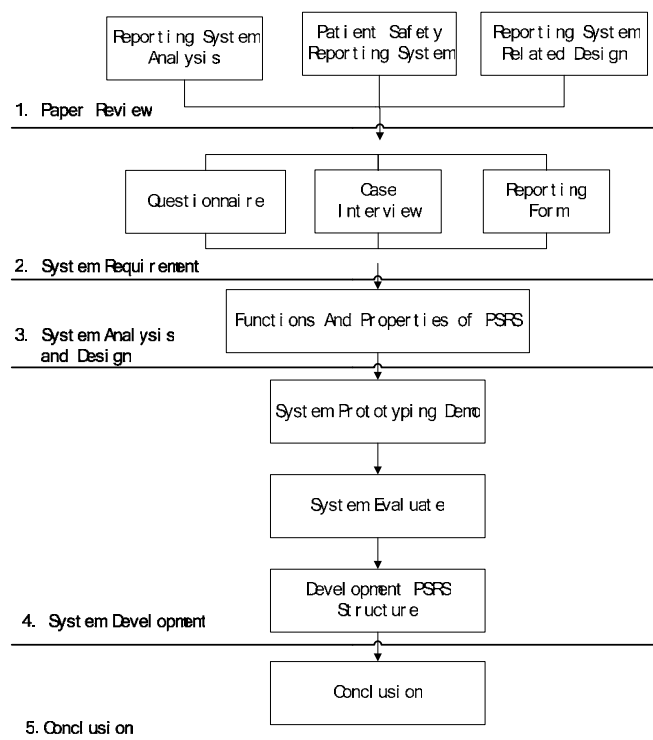


Figure 2 : Study Procedure

III. C

The research takes both the PSRS and the hospital information systems (HIS) into concern. In other words, the PSRS needs to be compatible with the existing HIS. The hardware and software structure are showed in figure 3. The system is developed by adopting Prototyping Method. Use PC to work as the system server, and SQL Server as the database. The system development tool is commonly used as ASP in HIS. Finally, Client/server structure is applied to construct the system on the internal network of the hospital.

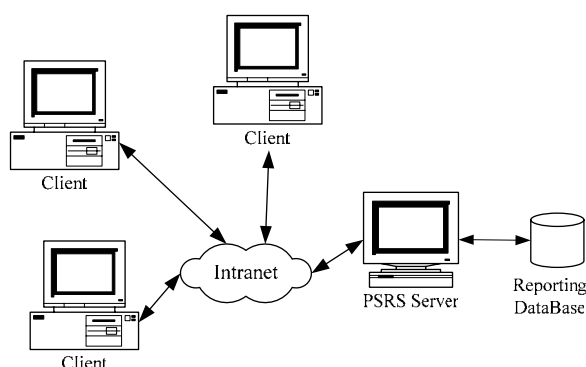


Figure3 : System Environment

SYSTEM FUNCTION

This PSRS is designed for a specific hospital by demand analysis of the interviewing, questionnaire investigation and literature reviewing. Figure 4 shows the PSRS functions and data need for the specific hospital. First, the input data

includes employee basic data, department structure data, and reporting data of medical error. Then, the system instantly deals with the reporting data as shown at the process stage. Finally, the system generates reporting events and reporting data analysis.

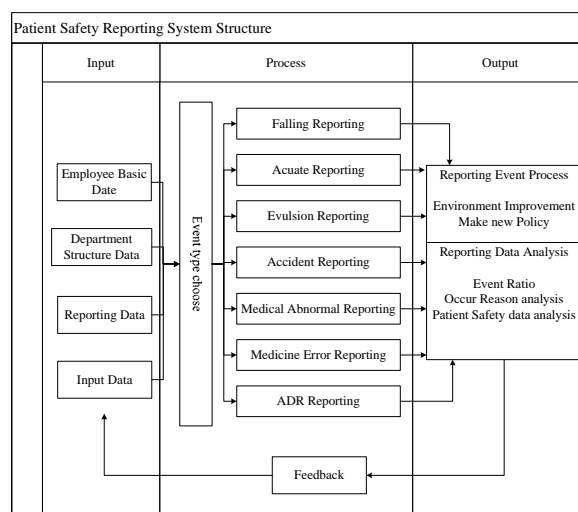
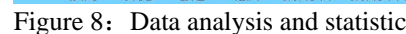


Figure 4 Patient Safety Reporting System Structure

IV. Display and Description

After logging the system (see figure 5), the reporting function page is show as figure 6. The users need to select the reporting type. Then, users have to input the needed data for the event that was intended to report as shown in figure 7. Since the description of the event is well structured, most of the inputs are just to click and check. There is a description box to enter text for anything that was not structured in beforehand. The system will store the input data automatically and send out an e-mail to notify the manager that supervises the reporter about the event. Then, the manager needs to log in the system and give suggestions or guidelines about the event to the reporter. If the event is cross departments, then the manager of the other department and the higher supervisor will be notified by e-mail automatically. In addition, the system also offers report and generates various types of statistical (see figure 8), depending on the type of report that users select. The monthly report of the events reported will be summarized and sent to the committee of patient safety of the hospital and further to the national patient safety committee.

Figure 5: User LoginFigure 6: Select Reporting typeFigure 7: Reporting data input

The assessment is done by questionnaire investigation through the internet. The subjects are staffs in the case hospital who have used the PSRS. The staffs give scores from 1 to 5 to represent first-rate to last-rate. Table 1 shows the comparison between the PSRS and the traditional paper reporting mechanism. The first-rates of paper reporting mechanism is easy to access the paper form to report while the PSRS is save on the manual distributing effort on the physical report. The best five that RSPR outperforms the paper mechanism are in the manual transferring effort on the physical report, environment protection, confidentiality, anonymity, and the efficiency of transferring the report.

System Property	PSRS		Improvement	
	Average	Rank	Average	Rank
Anonymity	3.39	11	0.84	4
Convenient to Report	3.42	8	0.39	13
Time Saving	3.39	10	0.45	12
Ease of Use	3.53	4	0.66	8
Transferring Time	3.55	3	0.81	5
Feedback	3.37	13	0.54	10
Confidentiality	3.41	9	0.92	3

Environment protection	3.50	6	0.96	2
Security	3.19	14	0.49	11
System Cost	3.48	7	0.78	6
Manual Transferring Report	3.63	1	0.99	1
State Monitor	3.52	5	0.74	7
Form making	3.58	2	0.65	9

According to the questionnaire results shown above, the average score of paper reporting system are all below than 3 except in the item of ease of access. Therefore, it is obvious that users were not satisfied with the paper reporting system. In the contrast, the average score of PSRS are all higher than 3 points which reveals that users are more satisfied with the PSRS. Hence, the computerized PSRS is extremely beneficial.

V. Conclusion

The result of this research shows that utilizing information science and technology to report medical errors can not only offering efficiency and reducing cost, but also improve the

shortcomings of the traditional paper reporting, such as lack of confidentiality, anonymity, security, as well as the trouble of manual transferring reports. The PSRS enhances the users' reporting willingness and forms a good reporting culture inside the institute. One observation is worth mentioned that the reporters of paper reporting mechanism were most nurses and medical staffs the rest while the reporters of PSRS even include janitors. Moreover, after the reporting culture inside the hospital is formed, staffs can learn to prevent medical errors from previous experiences. From the aspect of information science and technology, more data analysis can be carried out when more data are accumulated, such as Data mining, Neural Network, and OLAP analysis, in order to find the unexpected pattern related to causes. This study is to develop a specific information system for a case hospital. The external validity may not be satisfactory. However, the experience of developing the PSRS can serve as a reference for other hospitals that intend to build their own computerized reporting system. With more hospital establish inside-hospital reporting system, the national patient safety reporting system then can have true and solid data to analyze. Then the government can set up policies or regulations based on the analysis and enhance the medical quality nationwide.

(Reference upon request)

Adoption of Wireless Handheld Technology: A Case of Queensland Healthcare

Raj Gururajan¹, Abdul Hafeez-Baig², and Clint Moloney³

The University of Southern Queensland^{1&2}

Queensland Health Department³

Toowoomba, Queensland, 4350 Australia

gururaja@usq.edu.au

Abstract: Wireless technology is considered to a component of emerging technologies due to its relative newness in business. The mobility offered by this technology has influenced the introduction of this technology in healthcare, especially for nursing profession as nurses are always moving between patients and wards. The main advantage provided by this technology is collection of patient data at point of care, to manage patient schedules and to manage pharmaceutical information as these are the tasks performed by nurses in their workflow. Further, the technology offers flexibility and mobility to nursing staff to enable them to access data while they are moving between wards and patients. Despite many comments, it appears that user opinions on the adoption of technology specific to nursing are not prevalently available as current studies are focused on the technical aspects. This study, through a grant won from the Queensland Nursing Council in 2004, conducted a set of 30 interviews with nursing staffs to identify adoption factors. A qualitative technique, namely interviews, was used for data collection purposes and the adoption factors were identified using an NVivo analysis. The outcome of the interviews is reported in this paper.

Keywords: Mobile Commerce & Business, wireless technology, health care, IS

I. Introduction

Prior studies indicate that wireless applications using handheld devices can provide significant advantages by providing solutions to some of the existing problems that healthcare professionals face. These advantages include the reduction in transcription errors arising from paper based documents (Sausser, 2003), data collection at point-of-care (Simpson, 2003), considerable reduction in the amount of paper work required (Sparks et al., 2001), administering medications by having text based alerts using these handheld devices (Dyer, 2003), remote monitoring of patients and connecting to other systems such as patient care (Yacano, 2002).

While prior studies have highlighted the advantages of handheld applications, they have not yet ascertained factors that determine adoption of such a technology. This study is

designed to determine these factors. Once the factors of adoption are ascertained and appropriate solutions put in place, healthcare providers can enjoy the benefits of the application of this technology by providing solutions to staff associated with any crises encountered (Davis, 2002), managing the increasingly complex information challenges (Yacano, 2002), complying with the rigorous regulatory framework (Wisnicki, 2002), reducing the medication errors (Turisco, 2000), generating affordable applications that allow for greater mobility (Athey & Stern, 2002). In addition to these, wireless applications would also provide benefits to healthcare due to its flexibility and mobility in providing for better data management (Wisnicki, 2002), including complex patient data requirements (Davis, 2002), proper integration of data to existing systems (Craig & Julta, 2001), and improved access to data from anywhere at any time (Stuart & Bawany, 2001).

II. Literature Review

In healthcare literature, the concept of wireless technology is discussed by many studies (Wisnicki, 2002; Dyer, 2003; Simpson, 2003; Sausser, 2003; Hu et al., 2002). For example, Wisnicki (2002) provides details of how broadband technology, a component of wireless technology, can be used in healthcare. The discussion provided by Wisnicki (2002) involves the high cost of setting up wireless technology in a healthcare setting, improvements to patient care using this technology and potential cost-effective quality of service to patients. Sausser (2003) provides information on how to improve clinical quality using wireless technology including challenges for maintaining security and privacy. Sausser (2003) also discusses the concept of portable devices for data collection purposes by providing an argument on benefits that can be realised using these devices. Simpson (2003), while critiquing the nursing domain, stresses the need for the innovative use of IT to improve patient care. He points out those new IT technologies can help address some of the chronic problems encountered including saving nurses time, skilled nursing care and home health care. He also provides details on the expended time per every hour of nursing care and suggests that new technologies would provide solutions to some of the acute problems of nursing due to this time factor. Dyer (2003) on the other hand provides details of how text messaging using wireless devices can be effectively used to remind patients of their appointments. He reports the idea behind a radically new

system of managing patient care in conjunction with modern telecommunication applications using wireless devices to improve the quality of patient care. Common to all these studies is the use of emerging technologies in healthcare and potential benefits that can be achieved.

While many other studies reviewed in the healthcare literature echo similar sentiments, none of these studies have examined the potential problems in data collection methods using wireless devices. It appears that almost all studies have taken this crucial aspect for granted. While some studies have indicated existing problems in collecting patient data and provided some theoretical solutions, these studies have seldom analysed the changing nature of information systems using wireless devices.

To understand the issues associated with data collection using wireless devices, the Information Systems literature is also reviewed. Such a review indicated that this area is not fully researched. For example, Redman (2002) states that the wireless technology is in its infant stages and warns of the potential pitfalls when IT providers rush to implement the technology; Shah (2001) warns of the slower speed of wireless networks compared with the desktop computers and highlights the potential problems that could be encountered by healthcare; the relative high costs to initially set up these wireless networks is highlighted by Shroeder (1999); lack of real time connectivity due to the mobility of the device and the problems associated with such mobility is highlighted by Stevenson (2001); the size of the screen and hence the problems that may be encountered to display data due to screen size while capturing data is stressed by Toms (2000); the problems that may be encountered due to the lack of provision for high quality graphic display on wireless devices is highlighted by Atwal (2001), and Bevan (2001) discusses the potential problems of capturing data using wireless devices due to the 'hard-to-see display' nature of these devices. While the above mentioned studies warn that problems could be encountered while using wireless devices, they also tend to agree that the usage capabilities of these devices are growing and hence these hardware related problems will disappear in a few years time.

What can be realised from this review is that the majority of the studies have focused on the 'hardware' or 'physical' component of wireless devices as this appears to be a focal point of interest to many authors now. Other studies can be grouped into the 'implementation' or 'management' of wireless technology in healthcare organisations as the cost appears to be a determining factor in such implementations. None of the studies reviewed appear to have examined the 'usage' aspects of wireless devices. While studies such as Davies et al. (1989) have examined the 'Technology Acceptance' in organisation and derived a model for such acceptance, the outcomes of such studies can't be generalised for wireless technology as the technology is radically different from the traditional desktop technology. With desktop technology, users source data by accessing them using wired and fixed devices. On the other hand, with wireless technology, the data comes to the users

via the hand held devices and this new paradigm gives users a lot of mobility and hence access to data.

While healthcare organisations are keen to save money, they are also keen to provide high quality services to their patients. Crucial to this high quality care is data collation and analysis for decision making. The raw data collected at point of care by nursing staff is converted into information by feeding the raw data into various organisational databases. Current literature highlights the importance of incorporating wireless devices in organisations without discussing how nurses are able to collect data effectively. Limited information is found on the factors of adoption and inhibitors associated with such devices. Therefore, this study conducted an investigation into the factors of adoption of wireless applications for data collection by nurses. The adoption consists of facilitators and barriers. The facilitators are the positive influence and the inhibitors are the negative influence. By doing so, this study will fill-in the gap in the literature and provide insights into those factors that need to be given priority while using wireless handheld devices for data collection purposes.

III. Research Plan

III. 1 Research Problem

This research aimed to identify factors that determine the adoption of wireless handheld applications in hospitals for data management by nurses. This research examined potential challenges in adopting wireless handheld devices due to the rapidly changing nature of technology and associated legislative framework. Based on the initial literature reviewed, the following research questions were asked in this study:

1. What are the factors of adoption of wireless handheld devices in healthcare for nurses?
2. What are the emerging challenges in adopting wireless handheld devices in nursing?

III. 2 Research Design

The focus of this research study was to investigate the factors of the adoption of wireless applications. Inference from the literature revealed that this was an under explored area which demanded investigation into the role of technology and that of human context in using the technology. Although prior studies in Information Systems and Health indicated that a quantitative approach would suffice, recent studies recommended that a combined approach (mixed methodology) of qualitative and quantitative methods would provide strength to the research outcome. Experienced researchers indicated that there was a need to include qualitative approach to study the human social and psychological factors (Remenyi et al., 1998).

The research study investigated human psychological factors such as training, ease of use, motivation, culture, causal ambiguity, absorptive capacity, and retention as factors influencing the adoption factors of new technology.

Factors identified for this research were limited and needed to be expanded further to accommodate other unknown factors that affect the adoption of wireless technology in a given setting. Hence this study included a qualitative approach with the use of interview methods to strengthen the research outcome.

This research was designed to capture a cross-sectional snapshot and a dynamic longitudinal picture of the acceptance of wireless handheld devices and their applications in hospitals. The data were collected using a qualitative technique, namely interviews. The data were collected from nursing staff involved in patient care and focused on their behavioural patterns of adoption and usage of current technologies and their opinion on the usage of wireless technologies. The interviews focused on understanding nurses' changing views and behavioural pattern. Three specific hospitals were identified for this purpose where wireless devices are used for data collection purposes. The hospitals were derived from government, private and regional sectors respectively.

The qualitative method employed in this study included semi-structured in-depth interviews to gain a sufficient understanding on the topic from nurses using wireless technology in hospitals. These interviews helped to identify any unknown factors that affect the adoption of wireless technology.

III. 3 Data Collection

The data collection involved two specific stages. In the first stage we reviewed the existing literature in order to identify various issues impacting the healthcare domain where handheld devices can be used. This is called as the 'exploratory' stage. The main purpose of this stage was to identify factors in order to derive an interview instrument. The second stage involved actual data collection. These two stages are explained below.

Stage 1 – Literature Review (exploratory):

Extensive literature review was carried out at this stage to integrate the materials available into the interview questionnaire. The questionnaire consisted of over 20 themes and an information sheet was prepared after this comprehensive literature review. The specific purpose of this stage of the study was to ensure that nursing staff were comfortable in answering the technical aspects of wireless technology as appropriate to their working environment. This stage did not identify any mediating factors and only main factors influencing the adoption of technology were the focus of this stage.

Stage 2 – Interviews (evaluative):

In order to extract opinions about technology in a specific domain such as healthcare, the choice of sample is crucial. This is because the opinions expressed by nurses should be unbiased and should pertain only to technology and not the effects of technology on their current workflow. The samples for this project were drawn from the

Queensland health department and each of the samples is currently holding a practicing license. Further, the participants chosen are working in wards and people with administrative roles have been eliminated from the interview.

While Information Systems research identifies a range of sampling techniques such as random and clustering, the sampling technique used for this study is classified as 'purposive' sampling. As we need healthcare staff with special knowledge of technology, this approach was followed in this study. The samples were chosen through the local medical district on their advice as their opinions on wireless technology was extracted based on their knowledge. Therefore, the samples needed to exhibit certain attributes that are related to technology adoption. This approach has been followed in many health studies.

In the second stage of the research a set of 30 interviews were undertaken. In order to ensure the interviews were conducted on time, the local health district was approached through one of the authors of this paper and suitable candidate groups were identified. After obtaining ethical clearance from both the principal university and the Health District, a research associate from the Health District was contracted to undertake the interviews. The interviews were conducted in such a fashion as to minimise any disruption to nurses' work schedule, ensure comfort of nurses in answering questions, minimise any travel time by interviewees, synchronise the 'interview' language with participants and to prompt nurses when unknown aspects were encountered by participants.

Prior to the interviews, the line managers were approached for permission to release staff for interviews. Initially a consent letter was distributed to obtain consent for interview and the list of people interviewed was provided to the Health District. The interview was recorded using a digital recorder and catalogued as per ethics requirement. These interviews were then transcribed for data analysis.

Participants for the interview were selected from the nursing staff in Queensland Health. The participants were initially screened for suitability as only nurses working with technology were considered for this purpose. Any nursing staffs involved with administration only were eliminated from the interview to avoid any unforeseen bias. Nurses with a vast background were chosen (pharmacy, oncology and emergency departments). As the nurses belonged to the Health Department, no further screening was employed for sampling.

The instruments of this research consisted of two broad categories of questions. The first category of questions was related to the adoption and usage of wireless devices in hospitals for data collection purposes. The second category consisted of demographic variables. Open ended questions were included in the instrument to obtain unbiased and non-leading information. Prior to administering the questions, a complete peer review and a pilot study were conducted in order to ascertain the validity of the instrument. A two stage approach was used in administering the instrument, where the first stage would gather information about the key

factors influencing users' decision to use wireless applications and the second stage on the importance of those key factors. This approach was followed in this study in order to complement the open ended questions so as to determine the importance of the individual factors determining the adoption and usage of wireless devices and applications.

III. 4 Data Analysis

The data was analysed using NVivo software application. Prior to the analysis of data, the interviews were transcribed using university services. The transcribed interviews ranged from 8 pages to 17 pages in length, covering a total of 260 pages of rtf format file. Two experienced transcribers were involved in the process of converting the interviews into a computer file.

Once the files were transcribed, they were read while listening to the conversation in order to verify accuracy of transcription. Any bits that were missing during the transcription process was filled in as the researchers possessed sufficient knowledge of various technical terms used in this domain. The files were then printed and scanned for facilitators and inhibitors. These themes were identified on paper and then used as nodes in NVivo while examining the text files.

Once the themes were identified as free nodes using NVivo, the text snippets were examined again to aggregate the nodes into groups. Initially over 200 free nodes were realised and they were grouped into facilitators and inhibitors by examining the text passages again. They were grouped into the two major categories as trees and a simple correlation analysis using the table facilities was also performed on the various nodes.

III. 5 Results

The analysis using NVivo confirmed that the following facilitators and inhibitors can be extracted from the data collected from nursing participants. Our aim was in identifying the factors impacting wireless technology adoption. We did not attempt to classify them in an order of priority. However, we will be conducting more data analyses to classify them in proper groups and this exercise is beyond the scope of this project. The following tables list the facilitators and inhibitors of wireless technology adoption in nursing.

Table 1: Organized facilitators of the adoption of wireless hand held technology

Facilitators
1=Facilitators
2=volumes of information
3=user friendly
4=user friendliness
5=reduction of documentation
6=quicker response
7=more timely recording
8=mental health

9=medication schedule
10=medication errors
11=managing data
12=intensive activities
13=Health policy
14=handover reports
15=fantastic benefit
16=falls
17=cut down on the paperwork
18=current competence
19=benefits
20=avail lability of more time
21=alert clinicians
22=adverse event
23=advantages
24=access massive amount of information
25=remote monitoring

Table 2: Organized inhibitors of the adoption of wireless hand held technology

Inhibitors
1=Inhibitors
2=user friendly
3=user friendliness
4=unreliable
5=testing
6=short staff
7=secure
8=reliance
9=problems
10=schedule
11=How does it work
12=Health policy
13=coverage
14=confidentiality
15=awareness

III. 6 Specific comments on the factors

Facilitators – this factor indicates the positive influence of wireless technology on nursing. This factor also indicates that due to the positive mind frame, nurses will be keen to adopt the new technology in their setting.

Volumes of information – nurses indicated that wireless technology will help them manage the volumes of information. This can be realized due to the mobility and flexibility offered by the technology. This factor also correlates with data management, more timely recording and medication schedule.

User friendly – participants indicated that user friendliness of mobile applications will enable them to get their work done better. The distinction between user friendly and the next factor user friendliness was not clear. However, the term 'user friendly' was discussed while we were probing the technical aspects. Therefore, we believe that participants are referring to the applications used to conduct their daily work schedule and predominantly

indicate IT systems.

User friendliness – this factor was seen as a driver and was discussed while the management of technology was discussed. Therefore, we assume that the participants refer to the management of IT applications and the resources provided to them to conduct their jobs.

Reduction of documentation – this factor has been identified as a major driver by almost all interviewees. The nursing participants felt that wireless technology can provide the greatest advantage in this domain. This factor was linked to hand over reports.

Quicker response – this factor was mentioned in three specific contexts. The first one was accessing information in order to respond to various queries. The second aspect was in terms of various care management procedures. The third aspect was in terms of hand over reports and any query arising at this point of hand over. Participants believed that wireless technology in conjunction with better access would provide significant benefits in this domain.

More timely recording – participants felt that the mobility offered by the technology would enable them to record events in a more efficient manner than the paper based system. This factor was stated in conjunction with quick response and reduction of documentation.

Mental health – this factor was not recognized by all participants. We believe that this may be specific to a domain and highlighted in that context. Participants felt that wireless technology can help to track mental health issues such as monitoring patient movements using a handheld device. They expressed that wireless technology in conjunction with other technology such as Geographic Information System will accomplish tracking of patients specific to this domain.

Medication schedule – this is another area where participants felt that wireless technology can bring in significant benefits. Participants felt that handheld devices can help to track various details of medication schedules pertinent to patients. This factor was also linked with a reduction in paper work and timely recording.

Medication errors – this factor was almost agreed as a driver by all participants. The greatest benefit of wireless handheld technology appeared to be a reduction in medication errors. Participants commented that by introducing proper validation checks in the computer systems running on the wireless devices, instant validations can be facilitated leading to reduced medication errors.

Managing data – this factor emerged as a strong driver due to the mobility offered by wireless technology. Participants expressed their view that handheld devices will enable them to carry data as they move. This is also seen as a major paradigm shift in the way data is handled now. This factor is strongly correlated with a medication schedule and reduction in documentation factors.

Intensive activities – this factor was considered to be a less significant driver by the participants as they feel that the advantages provided by the wireless technology may be able to minimize the burden placed by their intensive schedule of

activities.

Health policy – this factor emerged as a driver despite the fact that certain participants questioned the current health policy. The consensus appears to be that if there is a proper health policy then the technology can deliver promises. Due to the positive perception exhibited by participants, we classified this factor as a driver, rather than an inhibitor.

Handover reports – participants expressed this as a major driver as almost everybody agreed that the wireless handheld devices can provide significant benefits in this domain.

Fantastic benefit – this aspect is categorized as a factor because the term ‘fantastic benefit’ emerged in many conversations. While participants were not able to clearly identify benefits, there is a positive feeling that the technology would be able to deliver benefits.

Falls – this factor was identified as a driver with a very specific cohort of participants coming from the aged care sector. We believe that these participants are already familiar with the handheld device to monitor aged care patients’ falls details.

Cut down on the paperwork – this factor emerged as a strong driver with links to reduced paper work and improved medication schedule. Participants agreed that handheld technology can definitely cut down paper work due to timely digital recording of data. Further, they also felt that this may reduce the errors such as transcription errors.

Current competence – this factor was discussed in a multitude of contexts. Some participants expressed that nurses are already handling a variety of technology and are therefore, competent enough to handle handheld technology. Others expressed that they are familiar with computing systems and hence possess necessary competence to manage handheld devices. This factor clearly indicates that nursing staff are not afraid of using new technology in their work.

Benefits – this factor was stated by a few participants while discussing the handheld technology. While this is a driver, the factor needs to be investigated further to identify what the actual and perceived benefits are.

Availability of more time – this factor emerged strongly with a number of people agreeing on this factor. The perception was that participants felt that they will be able to have more time to perform core functions because wireless handheld technology can assist them with data management.

Alert clinicians – participants felt that by using wireless technology, it may be possible to alert physicians in a more sophisticated way than the current ‘pager’ systems. They also felt that physicians can view various data associated with patients in a better way using the handheld technology.

Adverse event – this factor emerged as a driver because participants felt that wireless handheld technologies can provide more information in regard to adverse events because it is possible to store aspects of adverse events and retrieve them using this technology.

Advantages – this factor needs more investigation as participants stated there are advantages using wireless handheld technology. We were not able to glean more details from the interview schedule beyond this word.

Access massive amounts of information – this factor emerged as a major driver due to the perception that currently nursing professionals have to handle massive amounts of information which is carried in folders adding to the burden. Participants felt that the use of handheld technology may alleviate varying voluminous files and also provide access to data that is not available on hand while handling patients.

Remote monitoring – participants felt that wireless technology can facilitate remote monitoring using sophisticated methods. This emerged as a major driver because the majority of participants agreed that this be a driver. However, the concept of remote monitoring was expressed from monitoring a patient from their chairs to managing a patient in regional locations using this technology. This has a weak correlation with management's policy factor.

Inhibitors - this factor indicates the negative influence of wireless technology on nursing. This factor also indicates that due to the negative mind frame, nurses will NOT be keen to adopt the new technology in their setting.

User friendly – this factor indicates the technical component of wireless applications as applicable to nursing. Participants indicated that applications and computing systems should be user friendly in order to be adopted. It appears that current systems are not very user friendly and hence the negative bias in adopting new technology.

User friendliness – this factor was discussed by participants in terms of management support. Participants expected the supporting environment to be friendly in order for them to receive the necessary support.

Unreliable – this factor emerged as a major barrier because a number of participants discussed this under varying contexts from technology to management. The technical reliability of wireless coverage within health appears to be an issue. In addition, some participants also questioned the robustness of health policies in the wireless technology domain leading to major skepticism of the adoption of this technology.

Testing – this factor assumed minor importance as a barrier, as users insisted that wireless systems should be thoroughly tested prior to adoption. This factor was also correlated to education aspects.

Short staff – this factor emerged as a major barrier as many participants highlighted this issue. Participants highlighted the shortage of staff in health and its impact on technology adoption. One area that emerged here was the necessity for training and the impact it can have on staffing issues. This was weakly correlated to the policy framework.

Secure – this factor also emerged as a major factor as participants were concerned about this issue. The security factor was also discussed in terms of privacy and the impacts on their job. This factor had perhaps the most negative influence on the adoption of wireless handheld technology as it impacted performance.

Reliance – this factor was discussed by participants in terms of technology failure and their concern to resume

health activities without reliable technology. This factor was correlated with a number of facilitators such as access to information in a wireless environment.

Problems – this factor was categorized as a barrier because of the technical problems that can impact wireless handheld technology. This factor correlated with user friendliness in terms of support warranted when systems fail. Participants have again highlighted the need for robust policies in this domain and sufficient back up options.

Schedule – this factor was somewhat confusing as this was discussed under a variety of themes. The main negative feeling merged because of a proper schedule of wireless implementation in the participants' working environment. This has introduced a lack of direction as many participants encountered many different schedules for wireless implementation through varying policy statements.

How does it work – participants expressed this factor as a barrier due to the lack of training provided in the wireless technology domain. This factor was stated with the need for training.

Health policy – the lack of clarity in developing a rigorous policy framework has introduced a barrier to the adoption of wireless handheld technology according to the participants. They felt that a clear policy framework is essential as to the procurement of devices, usage framework, training, measurement etc.

Coverage – participants were uneasy as to the coverage aspects. This was discussed in technical terms and correlated with the policy framework.

Confidentiality – this factor emerged as a barrier when discussing access to information aspects. Participants highlighted that they were unclear as to the various confidentiality clauses and the impact on these clauses by using technology that is not well governed. This was considered to be a significant barrier by participants.

Awareness – this factor emerged as a result of the relative newness of the technology in the domain area. Participants expressed their concerns due to the newness of the technology in health and the need to raise the awareness as relevant to their profession. This also appears to be a major barrier in the adoption of wireless handheld technology.

IV. Discussion - Factors of Adoption & Emerging Challenges

Once these facilitators were identified from the interview notes, an effort was made to group them based on some arbitrary common themes among factors. While the interview data was analysed based on context, it was possible to extract four broad themes namely: ocumentation, information management, advantages and benefits. The documentation theme refers to any incentives to reduce paper work encountered by nursing staff. Information management refers to access to information and associated aspects. Advantages refer to positive and direct influences encountered in their daily operations. Benefits refer to

influences at organisational level as viewed by nurses. Themes that fitted these groups were identified and clustered under these four factors and a model was derived using NVivo.

Previous studies have already indicated that information management (Sparks et al., 2001) is a significant advantage using wireless technology. This was discussed by previous studies in terms of time management due to reduced information load (Sparks et al., 2001), reduction in medication errors (Sausser, 2003), and reduced documentation (Yacano, 2002). This study agrees with the previous notion that information management can be made easy by using wireless technology adoption. The new factors such as user friendliness, quicker responses, timelier recording and availability of more time for routine work appear to be the facilitators of the adoption of technology for healthcare professionals. Other comments indicate that healthcare professionals believe that the reduction in documentation and the quicker responses associated with the technology would be significant drivers of adoption. If adoption is slow, it may be more an indication of implementation problems rather than the perceptions of the relative advantage of the technology.

The inhibitors reveal details that are not found in the literature yet. For instance respondents considered the surrounding infrastructure to be a barrier to enable the technology. This is reflected in their statements to the effect that short staff, policy and work schedules are all considered inhibitors in adopting the wireless technology. This needs further investigation. The lesson from this exclusive exercise is that the factors of data management will drive the adoption of wireless technology in healthcare as this is where significant advantages can be gained. While some factors reported in this study are already highlighted by previous studies, this is perhaps the first attempt to extract views from users in a systematic manner. In addition to wireless technology, work settings appear to be impeding the adoption of technology. The implication of this aspect is that, in addition to the introduction of wireless technology, healthcare managers should consider the working conditions of their staff as these conditions enable the use of technology. In terms of theories used in the Information Systems Domain, there are five dominating aspects to technology adoption in any given setting. They are (i) relative advantage, (ii) compatibility, (iii) complexity, (iv) trialability and (v) observability. These five themes are well justified in this study. For instance, the theme 'Relative Advantage' is justified by the information management concept as expressed by the healthcare people in this study. 'Compatibility' is established through various discussions on access to resources including technology and devices. 'Complexity' is discussed by the participants by the information overload and the benefits that technology can bring in terms of time savings. 'Trialability' is highlighted by the fact that 'the technology is here to stay' and their implied willingness to trial new systems. Finally, the 'Observability' is mentioned in terms of various benefits that

can be provided by the technology.

In essence, while some factors correspond to the literature, emerging new factors indicate the benefits that this technology can bring to healthcare and associated facilitators of adoption. The next level of this research will look at the factors outlined by Rogers using an in depth analysis of the interviews and relate them to the factors identified by the nurses during their interviews.

V. Significance to Nursing

The study is significant to nursing for many reasons including the mobile nature of nurses, heavy data access when on the move, hand over reports, etc. Literature indicates that handheld devices can provide significant advantages to nursing by providing solutions to some of the existing problems such as the reduction in transcription errors arising from paper based documents (Sausser, 2003), data collection at point-of-care (Simpson, 2003), reduction in considerable amount of paper work (Sparks et al., 2001), administering medications by having textbased alerts using these handheld devices (Dyer, 2003), remote monitoring of patients and connecting to other systems such as patient care (Yacano, 2002). While prior studies have highlighted the advantages of handheld applications, they have not yet ascertained factors that determine adoption of such a technology. This study is perhaps the first attempt in Australia to identify these advantages by talking to nurses using an interview instrument.

VI. Conclusions

We found out that the adoption of wireless handheld technology by nursing staff received mixed feedback. While the facilitators are more than the inhibitors, issues such as security and awareness indicate the concerns to adopt new technology.

The driving force behind the adoption of wireless technology in a nursing domain appears to be the access to information and the management of volumes of information. While these two factors emerged strongly as facilitators, participants also felt that these two factors can reduce errors and paper work. We recommend that further research is now conducted on the issue of access to information, inclusive of an impact analysis.

In terms of inhibitors security, confidentiality and policy framework appear to be inhibiting the adoption. It can be noted that these factors are directly related to the management of technology rather than functional aspects of technology. These factors when combined with awareness and education issues indicate the reluctance of nursing staff to use the technology as the direction is not clear to them. If security, confidentiality and policy framework have effective corporate governance in raising staff awareness, this should overcome the barrier.

In essence, the data indicates that the facilitators are facilitated by the potential this technology can offer and the

inhibitors are the lack of management direction provided by the department or by the operating environment. In our opinion, while there is considerable enthusiasm to adopt new technology such as this, the participants are reluctant because they were not provided with comprehensive information as to how this technology can benefit them. This can be highlighted as an awareness issue, which is easy to rectify.

We believe that the effect of inhibitors can easily be minimised by adopting a training and education framework. This training framework will inform the nursing staff of the benefits, the policy framework and regulatory framework in their working environment. Once this is covered, a simple trial pushed from the top will enable staff to actually experience the benefits. This coupled with better technical support will influence users' decision to adopt wireless technology in their working environment.

We recommend that when considering the implementation of wireless technologies into the nursing profession that the adoption factors outlined in this report are taken into consideration.

In summary we believe that we have generated through this research an effective implementation model that will assist nurses considering the acquisition of such technology.

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Collaborative Forecasting under CPFR®

Henry C. Co and Juanita Roxas
College of Business
California State Polytechnic University
3801 W. Temple Ave, Pomona CA 91768
hco@csupomona.edu

Abstract: Collaborative Planning, Forecasting and Replenishment (CPFR®) is an inter-industry initiative driven by the Voluntary Interindustry Commerce Standards Association (VICS) to improve partnership between manufacturers and distributors/retailers through the exchange of information. This paper examines the assessment, communication, and reconciliation of forecast errors under CPFR®. A basic spreadsheet program is used to demonstrate how to facilitate analyses. Instructors can use this exercise to demonstrate examples in the classroom.

I. Introduction

Collaborative Planning, Forecasting and Replenishment (CPFR®) is an inter-industry initiative driven by the Voluntary Interindustry Commerce Standards Association (VICS) to improve partnership between manufacturers and distributors/retailers through the exchange of information. Its mission is to increase visibility along the supply-chain, thereby reducing the variance between supply and demand.

CPFR® evolved from CRP (continuous replenishment process), or better known as the vendor-managed inventory program (VMI). Successful VMI initiatives have been trumpeted by many companies, including Campbell Soup, Johnson & Johnson, European pasta manufacturer Barilla SpA, Shell Chemical, General Electric, Intel, and many others. However, inaccurate forecasts and undependable shipments have been major obstacles to higher performance.

Using decision support tools and standardized data formatting and communications, trading partners take equal roles in developing and managing a plan for "what is going to be sold, how it will be merchandised and promoted, in what marketplace, and during what time frame," based on the category management practices created as part of Efficient Consumer Response.

By eliminating procedures such as order processing and exception processing and taking into account factors such as the manufacturer's supply constraints and the retailer's promotion plan, both parties can use all the information available to make the best possible joint decisions.

CPFR® changes the relationship paradigm between trading partners. CPFR® requires redefinition of a company's goals and direction. It requires trust between partners. The sharing of product information, point of sale (POS) data and market intelligence among trading partners, usually through EDI or exchanges, is the building block to

CPFR®. Periodically, the retailers and their vendors would hold manual collaboration meetings to make their forecasts more accurate. With forecast collaboration, the vendors not only see the demand patterns of their immediate customers (the retailers), but also the demand patterns of the end-users. Thus, their forecasts reflect the actual consumer demand. Periodic collaboration meetings provide proactive decision making and adjustments, thereby improving replenishment orders execution.

This paper examines the assessment, communication, and reconciliation of forecast errors under CPFR®. A basic spreadsheet program is used to demonstrate how to facilitate analyses. Instructors can use this exercise to demonstrate examples in the classroom.

II. Forecast Errors and Accuracy

The calculation and communication of forecast error (or accuracy) measures among trading partners is crucial to the evaluation of demand planning activities. It is therefore important for trading partners to understand the parameters and alternative formulas for calculating and reporting these metrics.

II.1 Forecast Errors

Forecast errors are most often reported as absolute values. Regardless of whether forecasts are high by 8% or low by 8%, forecast error is still as 8% error. However, a source of confusion is in the calculation of the percentage forecast error. Some organizations measure the deviation of their forecast from observed (actual) values, while others measure how actual events deviated from their forecast. Both calculation approaches are widely used, and the only difference is the denominator:

- Deviation of Forecast from Actual: % Forecast Error = $(|Actual - Forecast| / Actual) * 100$
- Deviation of Actual from Forecast: % Forecast Error = $(|Forecast - Actual| / Forecast) * 100$.

If the deviation of forecast from actual is being measured, then the actual value is used as the weighting factor. Otherwise, the forecast value is used as the weighting factor. If a trading partner prefers results in terms of forecast accuracy, computing the forecast accuracy is straightforward. Subtracting the % forecast error from 100% yields the forecast accuracy, e.g., instead of reporting a forecast error of 8%, the corresponding forecast accuracy = $100\% - 8\% = 92\%$.

There are caveats in using the formula above to calculate the forecast error (or forecast accuracy). An obvious shortcoming is that by using an absolute error in calculating forecast accuracy, it is not possible to see whether there was an under-forecast or over-forecast an event without referring to the detailed data.

Another problem is that it is possible for the forecast accuracy to become negative if forecast error is over 100%! Since negative forecast accuracy is difficult to conceptualize, by convention any forecast accuracy value below zero is reported as zero (i.e., dead wrong!).

II. 2 Aggregating Forecast Errors

Frequently, forecast errors are reported not for a single item, but for a number of stock keeping units (SKU) across a number of locations. In this case, the relative weight of each individual item must be considered in calculating the error of the next level of aggregation. In practice, aggregation may occur across product, location, and time as follows:

- Product Dimension: SKU, Item, Brand, Category, Cross-Category
- Location Dimension: Store, Customer distribution center/ Store Group / Store Format, Customer, Channel
- Time Dimension: Day, Week, Month, Quarter, Year

In the following examples, it is assumed that the deviation of the actual value from the forecast is being measured. Hence, the forecast value is used as the weighting factor.

II. 3 Illustrative Example

The calculation and communication of forecast accuracy is fundamental in appraising demand planning activities. Unfortunately, the same reported result could indicate excellent or poor performance, depending upon how it was calculated.

Consider the following example. A product category consists of two SKUs, the forecasts and actual sales are shown below:

	Forecast	Actual	Absolute Error
	<u>Forecast</u>	<u>Actual</u>	<u>Absolute Error</u>
SKU 1	100	80	$ 100-80 =20$
SKU 2	80	100	$ 80-100 =20$
Category	180	180	$ 180-180 =0$

The % accuracy of SKU 1 = $100\% - 20/100 = 80\%$ and the % accuracy of SKU 2 = $100\% - 20/80 = 75\%$ (Note: the denominator used is the forecast). At the category level, the forecast is $(100 + 80) = 180$ units, and the actual is $(80 + 100) = 180$ units. This may lead one to think that the forecast accuracy at the category level is 100%!

The forecasts for SKU 1 and SKU 2 are 100 and 80 units respectively. The total forecast for the category is 180 units. Thus SKU 1 accounted for $100/180 = 56\%$ of the category total forecast, and SKU 2 accounted for $80/180 = 44\%$ of the category total forecast. Hence, the weighted forecast accuracy for the category is $(56\% * 80\%) + (44\% * 75\%) =$

78%.

Is the forecast accuracy for the category 100% or is it 78%?

When a forecast is calculated at the distribution center (DC) level, the calculated category forecast accuracy can be much different.

Suppose there are two DCs. The forecasts and actual sales of SKU 1 across all DCs are shown below:

	Forecast	Actual	Absolute Error	Forecast Accuracy
	<u>Forecast</u>	<u>Actual</u>	<u>Error</u>	<u>Accuracy</u>
SKU 1 at DC 1	50	30	$ 50-30 = 20$	$100\% - 20/50 = 60\%$
SKU 1 at DC 2	50	50	$ 50-50 = 0$	$100\% - 0/50 = 100\%$
SKU 1 Total	100	80		

The forecasts for SKU 1 at DC 1 and SKU 1 at DC 2 are 50 and 50 units respectively. The forecast for SKU 1 across all DCs is 100 units. Thus SKU 1 at DC 1 accounted for $50/100 = 50\%$ of the total forecast for SKU 1. Likewise, SKU 1 at DC 2 accounted for $50/100 = 50\%$ of the category total forecast. Hence, the weighted forecast accuracy for SKU 1 across all DCs = $(60\% * 50\%) + (100\% * 50\%) = 80\%$.

The forecasts and actual sales of SKU 2 across all DCs are shown below:

	Forecast	Actual	Absolute Error	Forecast Accuracy
	<u>Forecast</u>	<u>Actual</u>	<u>Error</u>	<u>Accuracy</u>
SKU 2 at DC 1	40	70	30	$100\% - 30/40 = 25\%$
SKU 2 at DC 2	40	30	10	$100\% - 10/40 = 75\%$
SKU 2 Total	80	100		

SKU 2 at DC 1 accounted for $40/80 = 50\%$ of the total forecast for SKU 2. Likewise, SKU 2 at DC 2 also accounted for 50%. Hence, the weighted forecast accuracy for SKU 2 across all DCs = $(25\% * 50\%) + (75\% * 50\%) = 50\%$.

Since SKU 1 accounted for 56% of the category total forecast, and SKU 2 accounted for 44% of the category total forecast, the weighted forecast accuracy for the category is $(56\% * 80\%) + (44\% * 50\%) = 67\%$.

The above example highlights the need for trading partners to have a consensus on the method of calculating and reporting forecast accuracy. That way, trading partners can better understand the performance being measured, and can duplicate the calculations from source themselves, if they desire. They can also request that a trading partner calculate a metric based upon data in their systems.

III. Negotiating and Reconciling

Companies conduct customer studies and competitive analyses to get a pulse on the marketplace. They also scan the environment for demographic trends, regulatory climate, technological developments, economic conditions, and so forth. Like internally generated data, this external

information most likely is continuously collected and monitored.

For example, manufacturing sees demand by SKU/plant, distribution sees demand by sales category/region, and retailer sees demand by cash versus credit sales. Different views of forecasts inevitably lead to different forecasts. The figure below acknowledges the different forecast views in a typical enterprise. The bottom level is the most detailed, typically with forecast for each stock keeping unit (SKU), region, channel, and brand. The higher levels represent aggregate forecast data at increased levels of summarization. These diverse working views are reconciled with one another to ensure that forecasts are consistent across the whole organization

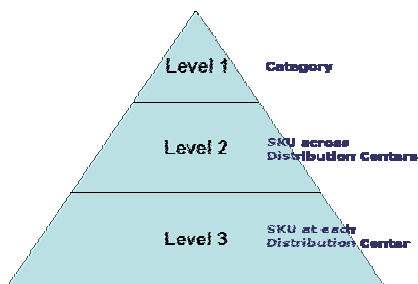


Figure 1. Hierarchical Forecasting

To produce a single unified statement of expected demand, the forecast has to incorporate and reconcile information from diverse sources inside and outside the corporation. To illustrate, consider the following example:

Level 3 (SKU at each DC) Forecasts. SKU 1 is sold to customers through distribution centers (DC) 1 and 2, while SKU 2 is sold through DC 3, DC 4, and DC 5. For the coming year, sales forecasts from DC 1 and DC 2 are:

SKU 1	Units	Price	Value
DC 1	8,200	\$20.61	\$169,002
DC 2	4,845	\$10.00	\$48,450
Total SKU 1	13,045		\$217,452

The sales forecasts from DC 4, DC 5, and DC 6 are:

SKU 2	Units	Price	Value
DC 3	7,000	\$20.50	\$143,500
DC 4	12,600	\$18.50	\$233,100
DC 5	8,400	\$21.80	\$183,120
Total SKU 2	28,000		\$559,720

These forecasts correspond to Level 3 Forecasts in Figure 1. The forecast for SKU 1 and SKU 2 across all DCs are \$217,452 and \$559,720, respectively.

Level 2 (SKU across all DCs) Forecasts. Suppose the forecasts of the product managers of SKU 1 and SKU 2 are \$250,000 and \$475,000, respectively. These correspond to Level 2 Forecasts in Figure 1. From Level 3, the forecast for SKU 1 across all DCs is \$217,452. How should one adjust the forecasts for SKU 1 at DC 1 and DC 2?

What about the forecasts for SKU 2 at DC 4, DC 5, and DC 6? The forecast for SKU 1 across all DCs at Level 3 is

\$559,720. Should they be proportionately reduced?

Level 1 (Category) Forecast. Suppose management has set a goal of \$750,000 for the category. This goal is \$25,000 over the sum of the sales targets (\$250,000 and \$475,000 = \$725,000) at Level 2. The category forecast of \$750,000 corresponds to Level 1 Forecasts in Figure 1. How should the product managers increase their forecasts, to be consistent with the goals of the category manager?

Adjusting Proportionately As a first pass, consider adjusting the forecasts proportionately.

First, the Level 2 forecasts (SKU across all DCs) should be revised to make them consistent with the Level 1 forecast (Category). To do this, the Level 2 forecasts must be adjusted by $(750,000 - 725,000) / 725,000 = 3.45\%$ (an increase). The revised Level 2 Forecasts are \$258,621 for SKU 1, and \$491,379 for SKU 2

Next, the revised Level 2 forecasts are used to adjust the Level 3 forecasts. The forecasts for SKU 1 at each DC must be adjusted by $(258,621 - 217,452) / 217,452 = 18.93\%$ (an increase). The forecasts for SKU 2 at each DC must be adjusted by $(491,379 - 559,720) / 559,720 = -12.21\%$ (a decrease).

The revised Level 3 Forecasts, SKU 1 at DC 1 and SKU 1 at DC 2, are 9,752 and 5,762, respectively. The revised Level 3 Forecasts, SKU 2 at DC 3, SKU 2 at DC 4, & SKU 2 at DC 5 are 6,145, 11,062, and 7,374 respectively.

Figure 2 summarizes all the calculations above. The date was entered into an Excel worksheet which shows the sum of forecasts at Level 2 (cell D18) = \$725,000. This is less than the Level 1 forecast of \$750,000 (cell D22). To reconcile the forecasts, the forecasts at Level 2 for SKU 1 and SKU 2 are increased by 3.35% (cells I16 and I17), respectively. The Excel formula for cells I16 is $I16 = (\$D\$22 - \$D\$18) / \$D\18 . The formula is copied and pasted onto cell I17. The revised forecasts are shown in cells H16 = $D16 * (1 + I16)$ and $H17 = D17 * (1 + I17)$.

To revise the Level 3 forecasts, the pertinent Excel formulae are:

$$I3 = (\$H\$16 - \$D\$5) / \$D\$5$$

Copy and paste onto cell I4

$$H3 = D3 * (1 + I3)$$

Copy and paste onto cell H4

$$I8 = (\$H\$17 - \$D\$11) / \$D\$11$$

Copy and paste onto cells I9:I10

$$H8 = D8 * (1 + I8)$$

Copy and paste onto cells H9:I10

	A	B	C	D	E	F	G	H	I	J
1	Level 3 (SKU at each DC)					Level 3 (SKU at each DC) Revised				
2		Units	Price	Value			Units	Value	% Change	
3	DC 1	8,200	\$20.61	\$169,002		DC 1	9,752	\$205,998	18.93%	
4	DC 2	4,845	\$10.00	\$48,450		DC 2	5,762	\$57,620	18.93%	
5	Total SKU 1	13,045		\$217,452		Total SKU 1	15,515	\$258,621		
6										
7							Units	Value	% Change	
8	DC 3	7,000	\$20.50	\$143,500		DC 3	6,145	\$125,979	-12.21%	
9	DC 4	12,600	\$18.50	\$233,100		DC 4	11,062	\$204,439	-12.21%	
10	DC 5	8,400	\$21.80	\$183,120		DC 5	7,374	\$160,761	-12.21%	
11	Total SKU 2	28,000		\$559,720		Total SKU 2	24,581	\$491,379		
12								Sum of Sq % Change	-0.3164%	
13										
14										
15	Level 2 (SKU across all DCs)					Level 2 (SKU across all DCs) Revised				
16	SKU 1			\$217,452		SKU 1		\$258,621	3.45%	
17	SKU 2			\$475,000		SKU 2		\$491,379	3.45%	
18	Total Category			\$725,000		Total Category		\$750,000		
19										
20										
21	Level 1					Level 1 (Category) Revised				
22	Total Category			\$750,000		Total		\$750,000	0.00%	

Figure 2. Adjusting Forecasts Proportionately

$J12 = \text{SUMSQ}(I3:I4, I8:I10)$. SUMSQ is an Excel function. SUMSQ (I3:I4, I8:I10) computes the sum of squared % changes (I3:I4, I8:I10) in Level 3 forecasts. It is a summative measure of the amount of changes in the forecasts for each SKU at each DC.

Optimization Model Collaborative forecasting is iterative. To adjust the forecasts proportionately across the board, the original forecasts for SKU 1 at DC 1 and DC 2 must be increased by almost 19%! The managers in these DCs may not have the necessary resources to attain the revised sales goals. Even if they have the resources, the market may not be strong enough to sustain a 19% increase in sales.

While DC 1 and DC 2 are expected to increase their sales target, DCs 3, 4, and 5 are actually asked to revise their forecasts downwards by -12.21%. If like most business organizations where performance is tied to the ability of attaining sales targets, this may become a sticking point among the managers in the organization.

The following exercise shows how an Excel worksheet can be used to demonstrate how the various organizations in the business can collaborate to arrive at an executable single forecast.

Level 3 (SKU at each DC)				Level 3 (SKU at each DC) Revised			
	Units	Price	Value		Units	Value	% Change
DC 1	8,200	\$20.61	\$169,002	DC 1	8,878	182,901	8.20%
DC 2	4,845	\$10.00	\$48,450	DC 2	4,959	49,591	2.36%
Total SKU 1	13,045		\$217,452	Total SKU 1	13,834	\$232,500	
	Units	Price	Value		Units	Value	% Change
DC 3	7,000	\$20.50	\$143,500	DC 3	6,477	132,780	-7.47%
DC 4	12,600	\$18.50	\$233,100	DC 4	11,340	209,790	-10.00%
DC 5	8,400	\$21.80	\$183,120	DC 5	7,600	165,674	-9.53%
Total SKU 2	28,000		\$559,720	Total SKU 2	25,417	\$508,250	
				Sum of Sq % Change			
Level 2 (SKU across all DCs)				Level 2 (SKU across all DCs) Revised			
SKU 1		\$250,000		SKU 1		232,500	-7.00%
SKU 2		\$475,000		SKU 2		508,250	7.00%
Total Category		\$725,000		Total Category		\$740,750	
Level 1				Level 1 (Category) Revised			
Total Category		\$750,000		Total		740,750	-1.23%
				Limits on % Change			
				Level 1			
				Level 2			
				Level 3			

Figure 3. Adjusting Forecasts Using Solver

First, notice that the % changes in Figure 3 are different from those found in Figure 2. The cells, highlighted in yellow, are called the decision variables. A tool in Microsoft Excel called Solver can be used to change the values of these decision variables. To use Solver, click Tools on the menu bar, and choose Solver. On the pull down menu, enter the following Solver parameters:

The Set Target Cell is J12, the objective function. Recall that cell J12 a summative measure of the amount of changes in the forecasts for each SKU at each DC. Solver is directed

to help minimize this value. On Equal to, choose Min, to minimize.

In the By Changing Cells box, enter \$I\$3:\$I\$4, \$I\$8:\$I\$10, \$I\$16:\$I\$17, \$I\$22. Solver is instructed to change the original values of the % changes (cells highlighted in yellow). These are the decision variables.

Next, Solver has to be taught how to solve for the decision variables. We do this by introducing constraints in the Solver menu.

To reconcile the forecasts, the forecasts at all levels should be consistent. Therefore, the sum of forecasts at Level 2 (cell H18) must equal the category manager's forecast (cell H22). Likewise, the total forecasts for SKU 1 at Level 3 (cell H5) must equal the forecast for SKU 1 at Level 2 (cell H16), and the total forecasts for SKU 2 at Level 3 (cell H11) must equal the forecast for SKU 2 at Level 2 (cell H17). These constraints must be entered one at a time as follows:

On the Solver Parameter menu, click Add to add the first constraint (Level 2):

After entering the first constraint, click Add to add the next constraint (SKU 1 at Level 3):

Again, click Add to add the next constraint (SKU 2 at Level 3):

In order to complete this task, additional information more information is required. In intra-organization collaborative forecasting, sales targets are to be adjusted based market outlook, and the resources available to the managers in each DC.

Collaborative forecasting requires hard work, high commitment, and willingness to give and to take. Suppose it is agreed that % change at Level 3 should not exceed 10% in either direction, and the % change at Level 2 should not exceed 7% in either direction. Furthermore, the category manager's forecast is constrained not to exceed 2.5%. This information must be translated into Excel formulae, and entered in the "Subject to the Constraints" box in the Solver

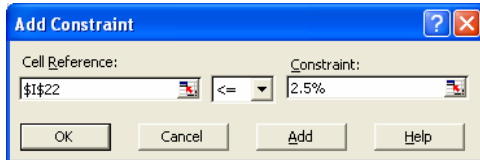
menu.

At Level 1, the constraints are $I22 \leq 2.5\%$ and $I22 \geq -2.5\%$.

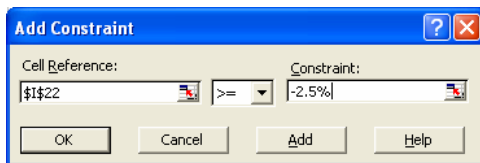
At Level 2, the constraints are $I16:I17 \leq 7\%$ and $I16:I17 \geq -7\%$

For SKU 1 at Level 3, the constraints are $I3:I4 \leq 10\%$ and $I3:I4 \geq -10\%$. For SKU 2 at Level 3, the constraints are $I8:I10 \leq 10\%$ and $I8:I10 \geq -10\%$.

Now, click Add to add more constraints:



Click Add to add another constraint:



Repeat, until all constraints have been added. Click OK when done.

Finally, on the Solver Parameter menu click Solve. This is how the optimal % changes in forecasts at all levels (Figure 2) were determined.

The above example, albeit an abstraction, stresses the process of integrating the planning activities across all functions in the organization into coordinated processes.

As shown in Figure 3, the category manager's forecast (Level 1) is to be adjusted downwards by 1.23%, from \$750,000 to \$740,750. This is within the 2% limit. At Level 2, SKU 1 will be decreased by 7% while SKU 2 will be increased by 7%. These adjustments are within the 7% limit. Finally, we see adjustments ranging from a 10% reduction to an increase of 8.23% at Level 3. Again, these changes are within the 10% limit.

The process appears to be straightforward.

Unfortunately, disconnects often occur within the corporate wall, coordinating activities of distinct legal entities along the supply chain often poses a much more formidable challenge.

IV. Conclusion

This paper illustrates the complex procedure involved in implementing CPFR. It shows the various levels of forecasting and highlights pitfalls in attempting to coordinate the activities of different levels of the firm and its Supply Chain partners. Instructors may find this exercise useful as a classroom example demonstrating how the use of a basic spreadsheet program (e.g. Excel), allows the possibility of reconciling many diverse perspectives from different levels of management into one coherent forecast.

Future studies can examine the imperative for

interorganization collaborative demand planning, and what industry is doing today to accomplish it.

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Contextual Bundling and E-Commerce: Strategizing for Online Bundle Formulation

Gaurav Mittal
Nokia Corporation

Abstract: Bundling has emerged as a key issue in current marketing and online business thinking. By extending contemporary conceptualizations, this paper proposes a new approach to bundling for both marketing of products and services in E-commerce. It reviews the literature on both bundling and consumer product evaluations and puts forward a new approach. It demonstrates that contextual bundling can constitute the strategic core of a company utilizing E-commerce for its business; at least if the firm's primary goal is to maximize the opportunities of attracting valuable customers, online content purchase and its consumption. This research carries forward some results from previous studies, while it finds other prior results to be questionable. Shows that strategic implications of online bundle formulation is only partially explained in terms of a price or product focus, which is where most of the previous research has concentrated on. A context specific price or product bundling focus can have more strategic implications than a simple price or product focus on consumer purchase evaluations. Businesses must define bundling through an in-depth appraisal of the actual contextual experience of the customers, rather than focusing solely on reservation prices, which is where previous literature has put maximum emphasis.

Keywords: Collaborative commerce, Consumer perceptions, Bundling (marketing), Strategy.

I. Introduction

The notion of electronic commerce (E-commerce) has been gaining in popularity with the rise of commercial activities on digital networks, especially on the Internet. In the academic world as well as in commercial organizations, many analyses see the Internet as a way to re-engineer the relationship between the producer (manufacturers and service providers) and the final consumer, leading to major productivity progress in transactional activities. Bundling product with services and dedicating assets and learning capabilities to their production allow transaction costs to be reduced along with more customer satisfaction. Internet is often analyzed as a medium that will enable the establishment of a direct electronic relationship between producers and manufacturers.

Millions of technology products are/can be distributed via the Internet. The technology continues to advance with breathtaking speed, yet existing theory and practice fail to

provide clear guidance on how these technology products should be packaged, priced, and sold. At one end of the spectrum are technologies such as on-line market clearing [4] where transactions are made in a continuous setting, transaction possibilities may pass and information about future possibilities may be incomplete or unknown [4]. In on-line market clearing, buy bids and sell bids are matched to maximize some value, such as seller profit or market liquidity. This paper draws attention to the opposite end, on-line bundle formulation. Here the task is to match a buyer's needs with items offered by suppliers so that a single complete bundle is purchased. Excess supply and market liquidity are not concerns here. The sole focus is on the satisfaction of the buyer.

The approach proposed in this paper makes use of *expected utility theory* to facilitate the decision process [16, 31]. Basing purchasing decisions on expected utility maximization (as opposed, say, to expected cost minimization) seems appropriate because it is sensitive to the decision-maker's attitude toward risk and preferences for such attributes as item quality, compatibility with other items, and supplier reliability.

With the high volume of purchasing options available on Internet today, strategic tools that can cleverly ascertain the true value of several different options are becoming important. More businesses are turning to web-based pricing tools that sift through large volumes of data on product revenues, inventory levels to determine how much to charge for items during certain periods [15]. Still others are resorting to dynamic pricing, whereby prices can change in time as well as across consumer markets and across packages of goods or services [13]. Dynamic pricing is utilized not only to maximize profit by responding to changes in supply and demand, but also to discourage the use of price-comparing shoppers by rendering them unreliable. These pricing strategies translate into higher profits for business, mostly at the expense of the consumer.

The focus of bundling literature till now has been on price discount. The literature on consumers' perceptions of price discounts is grounded in prospect theory [12] and mental accounting [30]. This literature suggests that in risky situations, consumers are more sensitive to possible losses than to possible gains, and that they are likely to accept more risk when potential losses are aggregated. Losses are aggregated when several losses are summed and presented as a single unit. For example, if an investor sees losses in a portfolio only once after three months (e.g., in a quarterly financial statement), he/she will be more willing to take risks than if he/she saw the same losses with greater frequency (e.g., by reviewing the portfolio daily or weekly). The

principle of aggregated losses suggests that bundling several otherwise risky products together might reduce perceived risk, as the bundle would offer several distinct benefits (gains) for one price (loss).

Bakos and Brynjolfsson [3] conclude that the economics of aggregation are in many ways similar in effect to economies of scale or network externalities. A marketing strategy that employs large-scale bundling can extract greater profit and gain competitive advantage from a given set of goods. Economies of aggregation will be important when marginal costs are very low, as the case for the (re)production and delivery of information goods via the Internet.

Recent research has found that consumers who buy a bundle of products at a bundled price consume less of the bundle than do consumers who are presented with separate product prices [22,27]. Consumers who buy a bundle of products at a bundled price perceive far greater ambiguity on the cost of their purchase than do consumers presented with separate product prices. This greater ambiguity "decouples" the cost of the purchase from the extra benefit of consuming the entire bundle. In other words, consumers who are presented with a bundled price will account less for the costs of their purchase than will consumers who are presented with separate prices [29].

This approach questions, among other things, the role of price and product bundling as the primary and only means of an online bundle formulation. The importance of product bundling is not questioned as such, but bundle formulation is rather seen as a measure of overall value offering to the consumer. More room and insight is required to listen to the consumer voice and taking his views, needs and opinion into account in strategic decision-making.

This paper addresses the online-bundle formulation (OBF) problem. The task of OBF is to decide which of many satisfactory combinations (bundles) of items should be formulated to maximize the buyer's overall satisfaction. Satisfaction, formalized as multi-attribute utility, includes product experience, consumer valuation, reputation, price, information and risk. This paper extends the contemporary conceptualizations about online bundling and proposes a new approach to bundling for both marketing of services and products in E-commerce.

II. Contextual Bundling

Contextual bundling is all about bundling to optimize the end user experience in a specific context, says Mittal [19]. An illustration of this phenomenon to offer "complete" product bundles is wireless operators initiative to integrate handsets, networks, content and services to produce an end-to-end, easy to use mobile Internet experience. The customer experience is transformed by ease of use, tailored packaged services for communication, organization, entertainment and information needs of the consumers on the move, improved quality of sound and content, encouraging increasing adoption and usage of online services. This is supported by a

new, easy to understand pricing model, designed to ensure customers receive simpler bills and to encourage usage through increased cost transparency.

Bakos and Brynjolfsson [2], find that when different market segments of consumers differ systematically in their valuations for goods, simple bundling will no longer be optimal. However, by offering a menu of different bundles aimed at each market segment, bundling makes traditional price discrimination strategies more powerful by reducing the role of unpredictable idiosyncratic components of valuations. Their findings appear to be consistent with the markets for Internet and online content, and copyrighted music.

A mobile Internet service provider or vendor, for example, is able to offer (alone or by matchmaking or through partnership) a variety of different offerings to a consumer. The service provider, in an effort to favorably affect the online content purchase and consumption may combine and optimize a-set of offerings to make the whole package work in a plug-and-play fashion. This takes the effort away from consumer; the package works optimally for the intended service(s) and enhances the consumer perception and hence increased content consumption. For example, an online-package with integrated Music player device, listening to Music service, installed settings to access the content and ready songs (content) on the move. This can be defined as *contextual bundling i.e. bundling of offering in a particular context*. In the above example, the context is "music on-the-go". The service provider or vendor in this case does not offer (n multiply n) offerings to the consumer. Other similar examples can be "TV on the go", "Click as you go", etc. The offering is focused in a particular context and experience for the consumer. In its most simple and basic form, contextual bundling can be considered as product bundling.

In the never-ending quest to gain and sustain a lead over competition, online businesses in a wide range of industries are turning to integrated solutions. They see integrated solutions as an *integrated chain* that is listening and responding to customer needs. According to Poirier [23], businesses see this chain as a mechanism for transforming their companies into enterprises that are more efficient and more responsive to customer demand.

Integrated solutions can result from both internal focus and external collaboration when the internal strengths do not match the other more skilled party. Poirier [23] has made a study of more than 300 global firms engaged in similar practices. This study revealed four levels of progression. The first two levels, where the vast majority of companies are situated, are internally focused. The two higher levels, embrace an external focus. Poirier also found that businesses continue to concentrate their efforts on internal excellence, ignoring the advantages external alliances bring. Higher level, by contrast, leverage shared resources to satisfy customers, resulting in increased consumer purchase and consumption. Needless to say, content consumption is the key for an online business.

Many organizations are building 'value-chain constellations'. These are organized networks of businesses that are working together, utilizing Internet, sharing resources and rewards in pursuit of targeted markets and consumers. Working as integrated units and focusing intensely on the targeted opportunities, these constellations are outperforming the less integrated units. Only a few companies in the lower level have managed to improve customer satisfaction.

The shift in power from sellers to buyers in digital economy has given the phenomena of co-engineering where customers cease to be product and price takers and instead become co-creators of product and price. Kotler et al. [17] refer to the roles that customisation, customerization and collaboration play in preparing market offers. Customisation occurs when companies offer solutions in response to unique demand, as when a doctor cures a sick patient. In this case the company takes the lead in designing the offers. Customerization describes the situations in which the customer, rather than the company, takes the lead in designing an offer. For example: Dell computer's online configuration tools allow customers to design their own computers. Collaboration occurs when a company and its customers actively dialogue and work together in co-customizing the offering. Many companies use extranets to dialogue with important suppliers and customers. Hence, the growing power of consumer makes dual-track communication with the consumer a major precondition of strategic success, and even more so when the aim is to win new customers.

Contextual bundles can also be understood in the context of widely accepted and proven concept of supply chain logistics. The two, partly share the goal to meet the demand for enhanced services by supplying more to the same customer and thus annulling the customers need to shop down the lane. Sussams [28] describes logistics as the science that integrates all the activities. It does not look at the individual parts of a system in isolation but looks at the ways in which the parts are connected and suggests better connection.

Complementarities can obviously create additional incentives for bundling, and thus can lead to the bundling of goods for reasons that have nothing to do with the reshaping of demand [7]. In addition to the goods being complements or substitutes, there may also be costs and benefits associated with producing, distributing, or consuming the bundle as a whole, such as economies of scale in creating a distribution channel, administering prices, and making consumers aware of each product's existence. Such economies underlie most large "bundles" of physical goods. For example, technological complementarities affect the collective valuation of the millions of parts flying in close formation that constitute a Boeing 777. Similarly, it is cheaper to physically distribute newspaper or journal articles in "bundles" rather than individually [2].

One of the effects of the emerging information infrastructure is to dramatically decrease distribution costs

for goods that can be delivered over networks. As noted by [5, 18] and others, this may be enough to make it profitable to "unbundle" certain goods, such as magazine and journal articles, packaged software and songs, to the extent they were formerly bundled simply to reduce distribution costs. The opposing effects on bundling of lower distribution costs because of networking and lower marginal costs due to digitization were first noted by Hanson and Martin [11] and are applied to the analysis of bundling, site licensing, and subscriptions by Bakos and Brynjolfsson [3].

Even with zero additional costs, the benefits of context specific bundling may be eliminated if the bundle includes goods that have negative value to some consumers (e.g., pornography or advertisements). Same goes with asymmetric bundling, while technology is rapidly reducing the costs of reproduction and transmission, the time and energy a user must spend to identify the "desired product" can present a barrier to the limiting result of contextual bundling. For example, the research found that the many users found Phonebook "Backup" service with mobile phone purchase as very valuable but the same users felt annoyed when their new mobile just had a "Sync" icon with no service behind it (eating the menu space in their mobile with it being of no practical use to them).

Thus, on-line companies can achieve a higher market penetration and deepen the value for its customer by creating market offers to match the customer's contextual experience. This can be achieved by offering context specific bundles to the customers.

III. Empirical Evidence

The research approach of this study is best described as action analytical, with clear orientation towards understanding the effect of bundling on consumer purchase intentions. The "action" in this study is represented by intentions and experiences related to on-line bundling, which provide a new point of analysis and understanding consumer purchase intentions.

The action analytical analysis in this study is a methodological combination of interpretative study of concepts, theme analysis [8] and Alasuutari's [1] factist perspective. Research method is defined as consisting of those practices and operations, through which the researcher produces *observations* and those rules according to which those observations can be further *interpreted* as possible leads in solving the problem [1]. The phases, producing observations and interpretation, are partly integrated, describing the process through which the mystery is solved [1].

As a part of research, the author conducted a survey of the consumers utilizing digital technology products like a mobile phone, digital camera, Internet services etc as a part of their day-to-day life. The aim of the survey was to study the consumer evaluations for different forms of bundling, giving practical real-life examples.

The target group was selected at random and no specific

prior condition is laid down to pre-select the survey respondents. At the same time, to ensure wider geographical coverage respondents from North America, Europe and Asia, who could understand and communicate in English, were approached to fill the survey. The survey was conducted both in electronic and paper form. The preference at all times was to have the survey conducted in electronic form and participants were encouraged to send the reply of survey in electronic form.

The main topics of the survey are identified based on the preliminary theoretical framework, but the language and variable scales were justified with a pilot round done with few respondents. Once satisfied that the respondents are able to understand the questions and complete within 10-12 minutes, the survey was sent with a possible deadline of 3 weeks. Within the deadline of 3 weeks, 104 filled-in forms were received.

The survey responses were partly analyzed with the SPSS® 13.0 program and in an exploratory manner. According to Olkkonen [21], this kind of approach is often used for new problem areas, in order to find out what the problem is actually all about. Typically, the empirical material in this approach is collected and analyzed according to the researcher's personal understanding of the problem area. The explorative method usually, and also in this study, serves well as a basis for future research in the area.

III. 1 Summary of Empirical Results

The respondents had the most favorable attitude towards the "Availability of Right mix of features". It is a significant finding that more than half (62%) of the respondents feel that availability of right mix of features as the most important characteristic that affects their purchase decision involving a bundled product. Here, the availability of right-mix of features can be understood in terms of what consumer feels is the right mix, meaning providing the experience to the consumers in their own specific context. The consumers value the product most in their own specific context and the consumer valuation comprises of experience from the product, positioning of product, reassurance to the viability of concept, relative advantage of the product as perceived by the consumers. Figure 1 shows the consumer responses during the survey.

The next important characteristic that affects consumers purchase decision involving a product bundle is availability of price discount. Thirty-five (35%) of the survey respondents feel that availability of price discount as the second most important characteristic that affects their purchase decision involving a bundled product. This can be understood in terms of price promotions, product consumption and number of (loss) transaction involved in the purchase. The literature shows that consumer perceive each transaction as a loss transaction [12, 30]. Price discount, higher consumption and reduced transaction costs are typical elements in price bundling.

The third important characteristic that affects consumers purchase decision involving a product bundle is availability

of wider features. Survey results point that thirty-five (35%) of the respondents feel that availability of wider features as the third most important characteristic that affects their purchase decision involving a bundled product. This can be understood in the light of product bundling. Typical elements that define a product bundle are risk mitigation, innovation, brand and a higher user base when involving new, technology, such as Internet, product bundles.

The least important of the four characteristics that affects consumers purchase decision involving a product bundle is availability of custom build product. It is a significant that about half (44%) of the respondents feel that availability of custom build product as the least of four important characteristics that affects their purchase decision involving a bundled product. This can be understood in the light of information needs of the consumer, information search efficiency, complexity of the decision-making environment. Such bundles are effective when the product is fast becoming a commodity and the capability of differentiation is minimal.

IV. Discussion and Conclusions

Adoption of new products can be influenced by economic constraints. Consumers may delay adopting a new product because they feel its price is too high [24] or they expect its price to fall [10, 20]. Under such conditions, consumers prefer to wait and see results from others who can afford to take economic risk [26]. Previous research suggests a relationship between price and perceived risk in two directions. Roselius [25] suggests that consumers may buy a more expensive product because they perceive less risk based on price-quality association. Alternatively, others argue that price acts as a constraint to purchase and represents a financial risk [14].

Marketers typically rely on price promotions to induce trial among nonusers for new products, to increase purchase volume, and/or to retain current consumers who might otherwise switch brands. Despite the broader implications of bundling, previous research has examined bundling primarily as a promotional vehicle that marketers use to sell two or more products together at a discounted price. The mention of consumer experience is totally absent in bundling strategies. It is clear from the consumer experience and valuation will drive the consumer to higher satisfaction and hence also higher purchase and consumption. We need to extend the meaning of *bundling* and decrease the ambiguity about the concept by understanding the core concepts of consumer valuation and purchase process.

Dhebar [6] suggests that technology markets are characterized by high levels of uncertainty related to product standards, product compatibility, availability of complementary products, and vendor credibility/reliability. Such uncertainties stimulate anxiety felt by consumers, which can manifest itself in hesitation to purchase, deferment of purchases, and in extreme cases, exiting the market altogether.

While increasing the rate of market acceptance is important to all products, it seems to be particularly important to increasing-returns-based high-tech products, where the need to jump-start the user base early in the product life cycle is critical. This argument suggests the value of acquiring and retaining early adopters (as opposed to later adopters) on the overall profitability of a new high-tech product [9].

Hence, from the consumer's perspective, newer, technology rich products present greater adoption due to high uncertainty related to product reliability, product compatibility, availability of complementary products and vendor credibility. In addition, consumers are concerned about rapid obsolescence and depreciation of technology products. Such high degree of uncertainties often causes apprehension, which can result in consumer hesitation to purchase, prolong decision-making complexity, deferment of purchases, and in extreme cases, canceling the purchase altogether.

A holistic concept of purchase intention is related to "determination or act to purchase", which also deal with the potential to experience, consume and satisfy. The consumer purchase research looks at things *from the payment perspective* of the consumer. In a complex, socially constructed consumer thinking, it is logical to assume that a bundling of a superior experience inevitably results in higher consumption and better satisfaction. With this logic, this study *challenges the unintentional assumption that price discount is a value as such*, inevitable and equal to better consumer experience. In order to question bundling as a means for higher market penetration, we need a feasible framework for analyzing the consumer purchase intentions. Figure 2 provides us with a combined framework bundling and consumer purchase intentions. What the figure above illustrates is the indispensable knowledge that consumer purchase intentions are defined by the total product experience.

The framework is a synthesis of the extant understanding in selected fields of consumer research that have addressed the issues of consumer psychology. To the framework's credit, its dimensions (consumer valuation, price discount, innovation and risk, and consumer information need elements) are *intuitively descriptive, conceptually independent, and do not lead to circular reasoning*. Each of the four dimensions is *grounded in well-established research*, rather than superficial management research applications. The framework leaves the prioritization for those applying the framework in their specific context.

The study proposes a new approach to bundling in the relation to contextual marketing. It also shows that strategic implications of bundling are only partially explained by price or product focus, whereas previous research has focused mainly on this aspect. A specific price bundle can have more strategic implications than a different specific product bundle, due to associative power of bundling and its interactive capacity. The study demonstrates that the distinction between transactional and contextual is key to

understanding the strategic relevance of bundling and the consequences to companies. Whereas transaction bundling is a promotional tool, contextual bundling is more strategic in that it greatly facilitates the consumer experience.

Consumers often do not use products to their true potential. Major cause for the same is the lack of understanding of the product and how the product can be used in certain situations to make their life smarter and easier. One of the purposes of bundling is to make consumer understand the product and its benefits more clearly. Today's consumer is often very busy and confused between the products and thus clear positioning and fit of product in consumers mind is often necessary. As a result businesses can effectively connect consumers with services, giving them possibility of recurring revenues. Bundling in a specific context, contextual bundling does exactly that; it educates the consumer about the various faces of the product related to different situation giving them a holistic experience and hence improved positioning of product in consumer's mind driving higher consumption and repeat online purchase.

V. Limitations and Future Research

This study has limitations that could be overcome in future extensions of this research. Future research could further test the findings of this study with respect to age and geographical location. For example: context specific experience can change to a great extent in different age groups.

It was noted during the course of this study that younger age group (20-25 yrs) were more price sensitive than older age groups (30+ years). Such an age-based analysis of consumer purchase intentions was considered outside the purview of this study; however, further research can be helpful to create more targeted bundles for specific age groups.

Similar to the above, it is possible that consumer preferences can vary with respect to geographical location and the state of economy where the consumer is residing. It is possible that consumer preferences in developed economies can vary to the preferences in developing economies. Further research can be helpful to create more targeted bundles for specific geographical locations.

The consumer purchase intention framework looks promising, but calls for more detailed and profound research. Answering the following questions would allow cause-effect and longitudinal studies:

Are the dimensions and elements of consumer purchase intention valid, and are there missing elements?

In this study, I examine only four factors influencing consumers' intentions associated with a purchase of a product bundle. Future research may include additional factors such as consumer innovativeness, purchasing power and risk aversiveness. Innovators might react to a bundling strategy differently than other consumers would. Since many

product categories from software to communication services are considered new-technology, future research might address how bundling strategies affect consumer decisions in different product categories. Future research might also explore marketing tactics that might be used to influence consumer perceptions of bundle positioning (i.e., which product is treated as anchor or tie-in; see [32]. Finally, I hope this study will stimulate further research in the areas of bundling, consumer purchase intentions and new product introductions in new technology markets.

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Thinking of purchase decision, involving a bundle, which of the following affects you? (Mark 1-4 in the order of importance with 1 as highest)

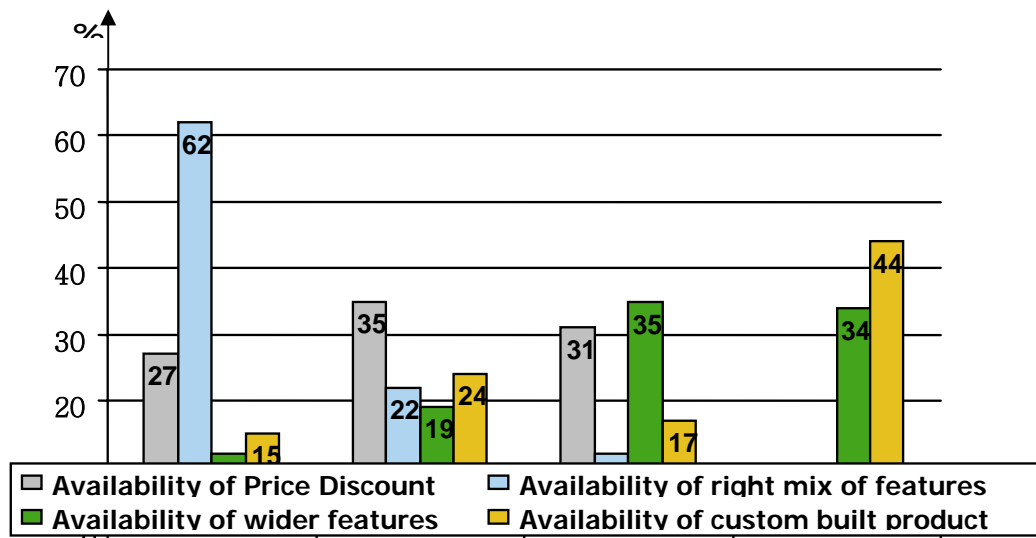


Figure 1: Consumer preference indicated in the survey.

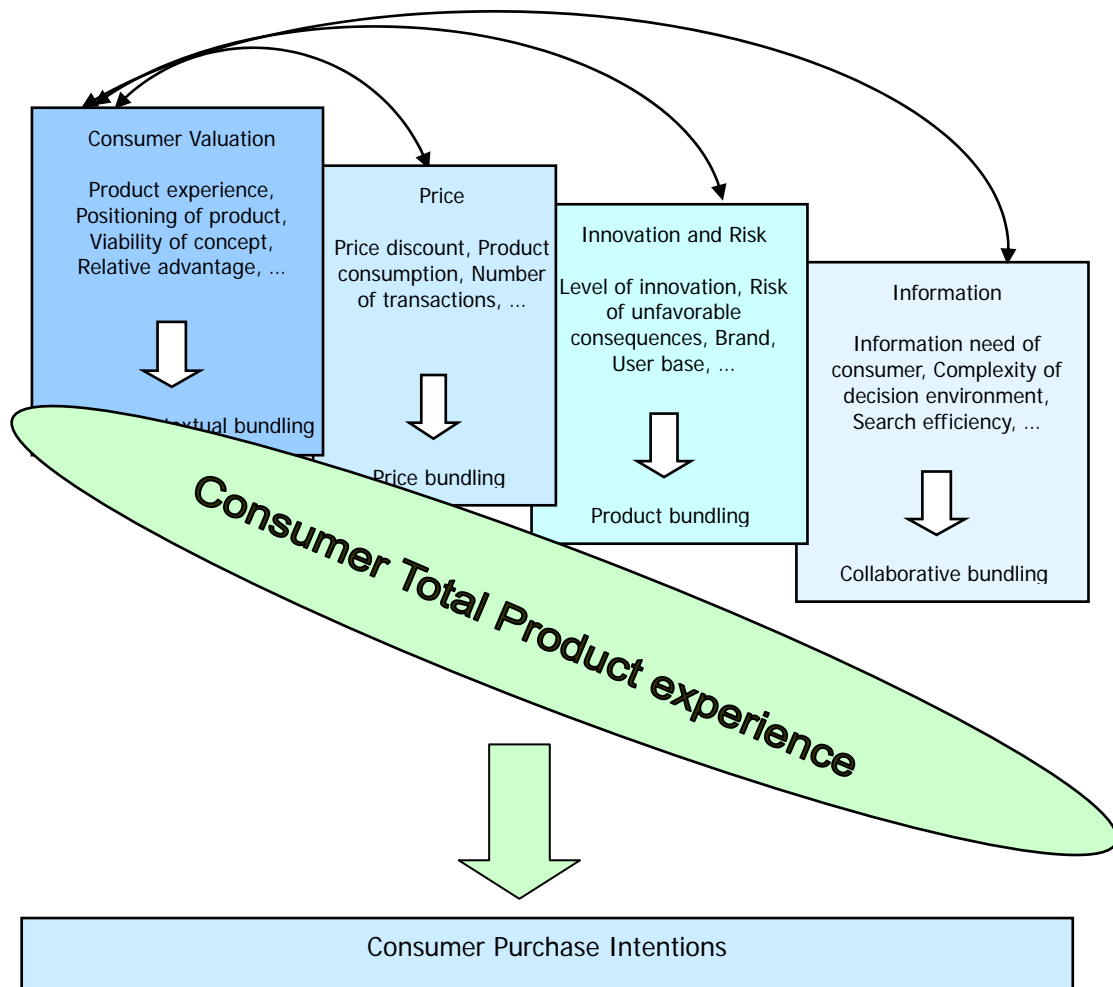


Figure 2: a combined framework of bundling and consumer purchase intentions

Managing Coordination Costs of Interorganizational Relationships: An Analysis of Determinants

Geng Zhang, Zhenyu Liu

Department of Management Science, Xiamen University, Xiamen, P.R.China, 361005
zhanggeng001@126.com, zhenyliu@xmu.edu.cn

Abstract: This paper presents a framework of the determinants analysis of the control of interorganizational relationships (IOR). While drawing on transaction cost analysis and resource-dependency theory, the authors analyze the effects of asset specificity, environmental uncertainty, level of dependence and trust on coordination costs of IOR. The explanatory power of the framework is assessed by a case study of buyer-supplier relationships from manufacturing industry in China. The findings from the case study suggest asset specificity, environmental uncertainty, and trust are the main determinants influencing coordination costs of buyer in IOR.

Keywords: Collaborative commerce, Interorganizational relationship, Coordination cost.

I. Introduction

Interorganizational relationships (IORs) are hybrid organizational forms which contain elements of both markets and hierarchies. Market exchanges are transactions between separate organizations, and hierarchical relationships are coordinated among organizations. IORs coordinate the activities of multiple organizations that are separate entities but cooperate with each other about their common concerns [15].

One important characteristic of IORs is cooperation, it refers to an agreement, relationship or exchange between two or more actors that is conducted by each of the participating parties. In past researches, many scholars highlighted the opportunities for mutual gains as the key motivation for IORs cooperation, including the gains as inter-learning, efficiency profitability, competent advantages, risk-resist ability and scale economic effect [15][10][8]. On the other hand, some authors have reported high failure rates of IORs. From a survey of year 1995 of Australia manufacturing organizations, Williams [15] find that approximately 38 percent of all respondent firms indicated that they had at some stage abandoned a cooperative arrangement, the main reasons being loss of control and lack of trust followed by the growing coordination cost of the arrangement. The wish to remain independent and remain control of their business operation was also the main reason of the failure.

A second characteristic of IORs can be described as the interdependence between partners. To create the transaction

value of common goals, partners should pool their resources together as well as determine the division of labor and the interface of activities between them. The resulting interdependence between the subtasks the partners agree to perform subsequently needs to be coordinated across organizational boundaries to ensure a fit between their points of contact [5].

Gulati and Singh [7] have stressed the importance of using coordination for managing task interdependence by arguing that "concerns about anticipated coordination costs are particularly salient in alliances, which can entail significant coordination of activities between partners". As the IOR's tasks become more interdependent and more uncertain, the need for coordination and decision making increases. Upon that, successful control of coordination costs becomes a key point on this cooperation relationship.

This paper develops a framework to analyze the determinants on the control of IORs in China, which is built on transaction cost analysis (TCA), resource-dependency theory (RDT) and notions of social control. We explain the framework from a case study of four buyer-supplier relationships on the manufacturing industry. Considering the availability of data, we will investigate the case from the buyer's perspective. In respect of the complexity and difficulty of measure on coordination costs, this paper does not try to examine the structure or measurement of coordination costs. Rather, we will focus on the inner relation between coordination costs and those influential factors.

This paper, in the next section, provides an analytic framework for measuring the determinants on interorganizational coordination costs from the TCA and RDT perspectives. Next, to explain the power of the framework, we employ a case study of buyer-supplier relationships from manufacturing industry in China. The paper ends with conclusions and directions for future researches.

II. Theory and Hypotheses

Detecting determinants on coordination costs of IOR can be studied from TCA perspective and RDT perspective respectively. The TCA has focused on the appropriation concerns in IORs, which originating from pervasive behavior uncertainty and contracting problems [3][11]. The basic assumption underlying the TCA perspective is that the specific governance form is based on an economizing on transaction costs. As asset specificity becomes substantial, interdependency is deepened and coordination is needed for

safeguarding the appropriation concerns.

RDT is a theory rooted in an open system framework, it focus on the ability that a firm must obtain necessary resources from external organization to survive prosper. The premise in RDT is that, firms confronted with an unpredictable environment will try to establish interorganizational relationships as a strategic response to uncertainty. The RDT perspective addresses the importance of the resources exchanged and the parties' ability to control the flow of input- and output resources [4].

When considering the management and control of IORs, we think the crucial concern is the magnitude of coordination cost. This paper considers both dimensions from TCA and RDT as potential determents on coordination costs. Besides the common premise of uncertainty dimension, we focus on examination of asset specificity from TCA as well as other dimensions from RDT and social theory, including level of dependence and trust.

II.1 Coordination costs

Many researchers argue that the coordination cost outweighs the benefits that an alliance can provide. How to control the costs is the key to allow a firm to realize the potential gains from alliance involvement [2][7]. The problem lies in the difficulty to measure it, as coordination costs can not be reflect from financial data. Considering business exchange is based on contract, Artz and Brush [2] suggest that coordination costs should be measured through contracting costs. They argue that IOR creates two types of contracting costs: the ex ante costs of initially establishing the contract, and perhaps more significantly, the ex post costs of periodically renegotiating and adjusting those contracts.

We also adopt the perspective of Artz and Brush and use the latter type of costs to measure coordination costs occurred in IOR. Therefore we use a similar approach as that suggested by Artz and Brush [2] and use the amount of time a buyer spends preparing for and actually negotiating supply contracts and the extent of conflict in the negotiation as indicators of coordination cost. In detail, we consider three aspects here: the amount of preparing time before negotiation, actually negotiating time and bargaining sessions, and the extent of conflict in the negotiations.

II.2 Independent variables and hypotheses

Asset Specificity. Asset specificity refers to physical assets, production facilities, tools and knowledge tailored to a specific relationship that cannot be re-deployed for other purposes without the sacrifice of productive value. When entering an IOR alliance, participants usually have to invest on assets with specific use only in this alliance. As regarding the manufacturing industry, a firm should, which is looking for appropriate supplier, make great effort on searching and evaluating the potential partners. This may consume a lot of capital, labor and time to establish and maintain the cooperation relationship. Besides, the participants should be locked in by special production equipment, computer technology and related interorganizational systems that link the buyer and supplier production and scheduling activities.

Substantial asset specificity creates bilateral dependence and may reduce the buyer's control over supplier. Therefore the buyer's coordination costs may rise. Accordingly we propose:

H1: In a buyer-supplier alliance, the association between buyer's asset specificity and buyer's coordination costs is positive.

Uncertainty. According to TCA, uncertainty refers to the condition of being able to predict relevant contingences surrounding the transaction. There are two types of uncertainties. One type is referred as environmental uncertainty which means circumstance surrounding an exchange cannot be specified ex ante. Artz and Brush [2] define environmental uncertainty as the inability to predict changes in relevant factors surrounding the buyer-supplier exchange, such as the changes in price of product input and the demand for end product. Therefore the environmental uncertainty makes it more difficult for the buyer and the supplier to negotiate contracts.

Another type of uncertainty is referred as behavioral uncertainty which means performance cannot be easily verified ex post. The effect of behavioral uncertainty is a performance evaluation problem, that is, difficulties in verifying whether compliance with established agreements has occurred [6][14].

When anticipated the supplier may have motivation to behave high behavioral uncertain, the buyer should consume more time and effort in negotiating contract for safeguard purpose. Accordingly we propose:

H2a: In a buyer-supplier alliance, the association between environmental uncertainty and buyer's coordination costs is positive.

H2b: In a buyer-supplier alliance, the association between supplier's behavioral uncertainty and buyer's coordination costs is positive.

Resource-dependency. As RDT provides a holistic approach with explicit recognition of economic and social-political dimensions of IOR [12], Ratnasingham and Kumar [13] argue that RDT is concerned with: (1) external forces such as e-commerce environment within which the dyad operates, (2) internal organizational dimensions that structure and shape written policies and procedures, and (3) trading partners' interactions in their general exchanges.

Similar to the descriptions above, this paper takes the suggest that these structure arrangement may be embedded whining socio-political characteristics of dyad, so we use level of dependency and trust as the dimensions of resource dependency.

Regarding the level of dependency reflects the extent that the buyer relying on suppliers for the resources they cannot produce themselves, so we suggest that:

H3a: The greater the level of buyer's dependency on supplier exists, the more coordination costs the buyer should use.

Sociologist viewed trust as an individual's confidence in the intentions and capabilities of a relationship partner and the belief that a relationship partner would behave as one hopes. In IOR's research, Ratnasingham and Kumar [13] indicate trust as a key factor for successful long term trading partner relationships, because high extent of trust between partners can increase cooperation, thus leading to communication openness and information sharing. Furthermore, they identified three types of trust existing in IOR: competence trust, predictability trust and goodwill trust.

Competence trust emphasizes the trust in trading partners' skills, technical knowledge. Predictability trust emphasizes the trust in trading partners' consistent behaviors that provide sufficient knowledge for other partners to make predictions and judgments due to past experiences. Goodwill trust emphasizes the trust in trading partners' care, concern and honesty that allow other partners to further invest in the cooperation relationships.

Summarily, we can view trust as a very lubricant that can help mitigate risk and coordinate interactions in business relationships. Hence, we argue trust may be an important mechanism to reduce the coordination costs, and suggest:

H3b: The greater the trust between the buyer and the supplier exists, the less coordination costs the buyer should use.

The hypotheses are summarized as figure 1.

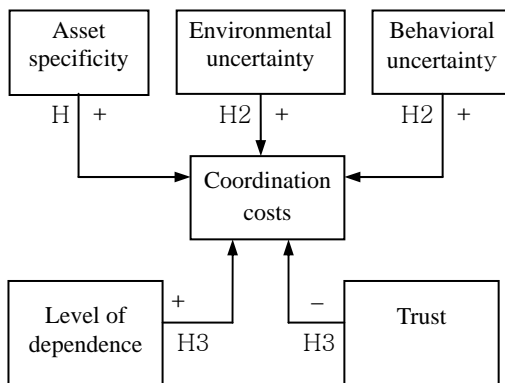


FIGURE 1: Determinants on coordination costs

III. A Case Study

On purpose of comparative, we select two electronic firms and two machine-making firms located at Xiamen city for in-depth study. These four firms are all stated owned firms listed on China Stock Exchange.

At first stage, we designed a survey based on buyers' perspectives of asset specificity, environmental and behavioral uncertainty, level of dependence on supplier and trust between the trading partners. Each dimension includes several items recorded on 1 (strongly disagree) to 5 (strongly agree) Likert scale. Next, we chose the interviewees as the managers of purchasing department or managers being responsible for R&D. Then we sent the surveys to interviewees beforehand and asked them to choose a supplier for certain product. Latter we arranged the interview with them separately for detailed discussion. The summary data in this case study is provided in table 1.

The electronic firms are Amoi Electronic Corporation and ABC Electronic Corporation. AMOI is a multinational electronic enterprise, which highly focuses on developing and manufacturing products from telecommunication, digital video & audio to IT industry. Nowadays Amoi has been an internationally well-known leading manufacturer and supplier of mobile phones in China. In 2003, this firm has employed about 20,000 persons and the total sales reached 850 millions US dollar. The interviewees chose the supplier producing screens used in mobile telephones.

The other investigated electronic firm is ABC which is an anonym. ABC is the leading professional manufacturer of Plastic Film Capacitors in China. Its current total annual capacity has reached 2.5 billions pieces, which can be ranked first in China and sixth in the world. The total employee is less than 2000, and the total sales are about 36 millions US dollar. The interviewees chose the supplier producing metal materials used in capacitors.

The machine-making firms are Xiamen King Long United Automotive Industry Corporation (XMKL) and Xiamen Engineering Machinery Corporation (XMEC). XMKL has taken up a leading position among domestic coach manufacturers and has hired 3500 employees with the total sales reached 542 millions US dollar. The interviewees chose the supplier producing engines used in coaches.

XMEC is the key enterprise of large scale for producing wheel loaders of the state. The company had been the birthplace of the first loader of China. The total employee is 2000, and the sales in 2003 reached 313 millions US dollar. The interviewees chose the supplier producing diesel engines used in wheel loaders.

We firstly compare the negotiate session with their own supplier between the two electronic firms. On average, both of them respond some extent of complexity in negotiation with their suppliers. To reach an agreement with suppliers on contract items, it often requires extensive preparation time and numerous separate bargaining sessions. This should belong to drastic competence and homogeneity of products existing in electronic industry. Therefore, electronic firms are always tried to strictly control the costs and quality of their product to gain competitive advantage in the market. This results tough negotiation with suppliers and increase the coordination costs of buyers. Investigated data shows that the two electronic firms received a same mean value of 3.6 on coordination costs. Rather, the average value of coordination costs for the two machine-making firms is much less, which is respectively 1.8 and 2.2. Both of the two firms attribute the relative easy bargaining process with suppliers to mature market of machinery industry.

Asset specificity. Amoi has gotten a greater value of 3.4 on asset specificity, and the value for ABC is 2.2, which is separately the max value and min value among the values of the four firms. The reason is that the supply of screen for mobile phone demands high customization, while the material for capacitors is high standardization. The engine and diesel engine used by two machine-making firms must comply with national standard, which make the asset specificity lower. As a whole, higher levels of asset specificity increase the difficulty the electronic firms experience in negotiation supply contracts. Although the coordination costs of ABC do not seem positive to asset specificity, this may be influenced by environmental uncertainty which increase the coordination. However, from the analytical perspective of industrial difference, this result can support the positive relationship between asset specificity and coordination costs.

Environmental uncertainty. As expected, the levels of environmental uncertainty of electronic firms are obviously higher than those of machine-making firms. ABC gets the greatest value of environmental uncertainty, which is not only two times than those of machinery firms but is also much greater than the value of another electronic firm. There are two causes can explain: first, the market price for

capacitors usually fluctuate violently. Second, the investigated component procured by ABC is metal material, which has been floated frequently in recent years suffered from international supply. In general, electronic industry confronted with drastic competence as well as fast technology innovation. Consequently the product prices and purchasing costs change frequently, along with the life cycle of product shorten. Suffering greater environmental uncertainty than machine-making firms, hence, electronic firms need more deliberately negotiate a contract. As a result, it suggests that higher levels of environmental uncertainty increase the coordination costs of buyer.

Behavioral uncertainty. Except for the lower value of Amoi, the levels of behavioral uncertainty of other three firms are almost the same. On account of the tiny distinction of these values which is nearly medial value, from this investigation we cannot get any conclusion on the relationship between behavioral uncertainty and coordination costs.

Level of dependency. Our data reflect that all of the firm present high levels of resource dependence on their suppliers for investigate. The primary reason is that the interviewees of the four firms have happened to choose the focal suppliers of their core products as investigating object. Among the firm, the level of dependency of ABC is lesser. Because there exist many manufacturers can supply metal material, in the other hand, ABC may find some other substitute if possible. In general, the distinctions among the levels of dependency of the four firms are not obviously. As all the values are distributed between 3 and 4, so the results suggest that the negative between level of dependency and coordination costs is not significant.

Trust. From table 1 we can see, the trust between buyers and their focal suppliers is reached a high level in the range of 4.29 and 4.57. Considering the greater value of trust dimension in the case study, we can conclude that all the four firms have tried to establish strong trusty cooperation relationships with their focal suppliers. Hence, to some extent of degree they have reduced the behavioral uncertainty of their trading partners and make the negotiation proceeding smoothly. As result, this finding support for Hypotheses 3b.

IV. Discussion and Conclusion

This paper contributes to focus on the determinants of coordination costs in IORs by considering the dimensions of TCA and RDT. Our model indicates that when studying the control of IOR, the economic dimensions and relational norms should be putted into consider simultaneously. There is little empirical study on such topic based on relationships of Chinese organizations, and this study also makes a valuable contribution by filling up this gap.

In this study, we investigate four manufacturing firms located in China belonging to different industry. The result shows that the Hypotheses 1 and Hypotheses 2a in our model have been significantly supported by the empirical data. That means in the context of China, the traditional TCA research is also useful in study of interorganizational relationships. We find that both asset specificity and environmental uncertainty directly increases the coordination cost of interorganization exchanges. And this finding is clearly consistent with previous TCA research [2]

[1] [9].

As the dimensions of RDT, this study supports Hypotheses 3b significantly. Therefore this finding indicates that trust can reduce buyer's coordination costs by mitigating behavioral uncertainty. Besides, trust between trading partners also plays a direct role in reducing buyer's coordination costs. On considering the effect of dependency level, distinction of the investigated data is quite tiny, and our study does not significantly support Hypotheses 3a. One possible explanation for this non-significant finding may be that the dependency level between trading partners in this study are too similar to manifest the different influential level.

While the findings of this study provide valuable insights, several future studies need research into the selection of determinants of IORs. For instance, our study has provided insight from the buyer's perspective, lacking of supplier's choice. Since the IORs are bilateral relationships, the successful control of IOR rely not only the action of the focal firm, but on actions of all the participants. Therefore, future research would analyze the determinants from the supplier's perspective. Finally, considering the shortage of case study method, it requires quantitatively methods using a number of IORs from a wide extent. This also remains an important challenge for future research into the management of IORs.

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TABLE.1 Summary data in case study

Firms	Coordination costs	Asset specificity	Environmental uncertainty	Behavioral uncertainty	Level of resource dependence	Trust
Amoi	3.6	3.4	2.4	2	3.75	4.29
ABC	3.6	2.2	3	2.75	3	4.43
XMKL	1.8	2.6	1.2	2.75	3.5	4.29
XMEC	2.2	2.4	1.6	2.5	3.25	4.57

A Proposed Framework for Influencing Factors of Partnership in E-Taiwan Collaborative Commerce

Hsueh-Foo Lin, Feng-Ling Huang, Meng-Yu Lin
Department of Information Management
National Pingtung Institute of Commerce
51 Min Sheng E. Road,
Pingtung 900, Taiwan, R. O. C.
Tel/886-8-7238700 Ext. 6230 Fax/886-7210844
sherry@npic.edu.tw

Abstract: This paper attempts to integrate concepts of a collaborative commerce and inter-organizational relationship to build a framework for influencing factors of e-Taiwan collaborative commerce partnership and empirically explore it. The importance for five dimensions of the Research Model based on seven top representatives of interviewed six Taiwanese companies engaged in E-Taiwan is summarized. Statistical analysis is used to decide which factors are vital for the success in three phases of partnership in e-Taiwan. Data are collected through a survey of organizations that are actively involved in the planning or operation of E-Taiwan collaborative commerce. The result has been shown the influencing factors are not the same in three phases of partnership in this collaborative commerce. It implies that to manage a collaborative commerce must have different strategies to select, develop, and maintain participants.

Keywords: Collaborative commerce, Partnership.

I. Introduction

In the past years, many organizations have tried to expand or broaden their supply chains in collaborative commerce. However, successful collaborative commerce is a challenge among the industry around the world, it maybe partly dues to the slow world economy making financing much more difficult for collaborative commerce, 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 a collaborative commerce.

Therefore, this research tries to cover the findings of studies on collaborative commerce 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 collaborative commerce to validate and justify the Research Model.

- (3) Questionnaire survey based on the research model and statistical analysis to explore the influencing factors of e-Taiwan collaborative commerce partnership.

II. Literature Review

Within the literatures, it is shown that appropriation of information technology such as e-marketplaces justifies organization behaviors [6, 11]. 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, 3, 8, 9, 12, 15]. Two major schools of thought have pursued the study of information technology and organizational changes. The decision-making school [17] emphasizes the cognitive processes associated with rational decision making and adopts a psychological approach to the study of technology and change. Institutional school [13, 16] 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 [6] 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 [6] 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. META Group) [1] proposed collaboration commerce into four functions as Design Collaboration, Marketing/Selling Collaboration, Buying Collaboration, and Planning/Forecasting Collaboration. According to the definition of META Group, E-Taiwan collaborative commerce can be treated as 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 decision making. This research attempts to explore “E-Taiwan Collaborative Commerce” proposed by Ministry of Economic Affairs of Taiwan, including plan A, B (Industrial Automation and e-Business Promotion Program, iAeB), C (Cash), D (Delivery) and E (Engineering Collaboration). They are collaborative operations to link with business process, content and domain knowledge exchanging that includes e-procurement, e-financing, e-payment, e-global funding, e-logistic, transportation planning, synchronization, design change and information sharing etc. The scope of “E-Taiwan Collaborative Commerce” denotes “the Center of Knowledge/Processing Transaction” of collaborative commerce. According to the definition of our functions of META Group, “E-Taiwan Collaborative Commerce” can be classified as a kind of collaborative and AIT.

Structural features are the specific types of rules and resources, or capabilities offered by the system. Features within “E-Taiwan Collaborative Commerce” 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-Taiwan Collaborative Commerce. Features of e-marketplaces bring meaning and control to group interaction. There currently is burgeoning interesting in e-marketplaces and their potential role in facilitating organizational and social changes. Once Collaborative Commerce is 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-Taiwan Collaborative Commerce”. Based on the meaning of each construct in AST, initial dimensions for the Research Model are listed as Table 1.

III. Research Model

Researches related to E-Taiwan collaborative commerce focus on finding characteristics and functions. The findings in literatures include information transparency, cost reduction, interdependence, partnership compatibility, low logistics costs, etc [4, 5, 7, 10, 14]. The influencing factors of each dimension are summarized in Table 2. The relationship styles of buyers-sellers in organizational.

Table 1. Initial Research Dimensions inspired from AST

Major Constructs of AST	Initial Dimensions for the Research
Structure of AIT	Characteristics of E-Taiwan
Other Source of Structure	Initial Leader of E-Taiwan
Group's Internal System	Members of E-Taiwan
Emergent Source of Structure	Industrial Environment
New Social Structure	Derivative Problems of E-Taiwan
Appropriation of Structure	Functions of E-Taiwan
Decision Process	Phases of E-Taiwan

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 [9].

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-Taiwan Collaborative Commerce, including a question about the relationship styles of partnership in E-Taiwan Collaborative Commerce in order to exploit participants' perspectives. Six top representatives of Taiwanese companies related to E-Taiwan are selected for expert depth interview to validate the Research Model. The companies interviewed are MiTAC International Corporation (plan B, C, D, E), Hewlett-Packard Development Company (plan A), Futaba Technology Development Corporation (plan D, E), China trust Commercial Bank (plan C), Systex Corporation (plan A,B, C, D, E) and Advanced Semiconductor Engineering, Inc.(RossettaNet). The importance of each research dimension based on opinions of seven executives of the interviewed companies is summarized in Table 3. The importance of All research dimensions are bigger than 75% that is set to be significant (i.e. significant dimensions must have three out of four interviewees mention at least). Based on the importance voted by six executives, the Research Model is proposed as Figure 1. Business model is an additional factors proposed by these seven interviewed representatives.

Table 2. Influencing Factors of Research Dimension

Research Dimension	Influencing Factors
Characteristics of E-Taiwan Collaborative Commerce	(1) information transparency (2) capability of information integration (3) ability of improving for transaction quality (4) cost reduction
Initial leader of E-Taiwan Collaborative Commerce	(1) credibility (2) *business model
Members of E-Taiwan Collaborative Commerce	(1) information sharing (2) ability of communication (3) exceptional management (4) commitment (5) trust (6) strong partnership (7) coordination (8) interdependence (9) compatibility of partners (10) performance expectations met
Industrial Environment	(1) e-business capability (2) standards setting
Derivative Problems of E-Taiwan Collaborative Commerce	(1) reform of business procedures (2) reform of organizational structure (3) degree of information transparency (4) compatibility among systems (5) security (6) *consistence of standards
Functions of E-Taiwan Collaborative Commerce	(1) inventory reduction (2) improvement of purchase order (3) accurate customer demand forecasting (4) e-payment (5) e-financing (6) e-global funding (7) reducing the financial cost (8) transparency of transportation (9) low of logistics costs (10) improving the quality of delivery (11) inventory control (12) transportation planning (13) quality of delivery (14) management of design change (15) reducing time-to-market (16) reducing the cost of design development (17) computer-supported (18) collaborative design (19)

* proposed by seven interviewed representatives.

IV. Primary Questionnaire Survey and Research Findings

Since the Research Model is justified and validated, the questionnaire survey is deployed next. In the questionnaire, questions (36 items for plan A, 39 items for plan B, 42 items for plan C, 46 items for plan D, and 38 items for plan E) are developed to related to the forty influencing factors of seven

dimensions in the proposed 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-Taiwan Collaborative Commerce. Thirty-four questionnaires are delivered and all recycled and considered effective after examination. For avoiding bias from extreme values, the geometric means instead of average means to evaluate answer values of questionnaire surveys. This research is hence used it to decide which factors are vital for the success in three phases of partnership in E-Taiwan Collaborative Commerce. The geometric mean of opinion 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-Taiwan Collaborative Commerce are summarized in Table 4.

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-Taiwan	27	28	96%
Initial leader of E-Taiwan	13	14	93%
Members of E-Taiwan	69	77	90%
Industrial Environment	14	14	100%
Derivative Problems of e-Taiwan	106	112	95%

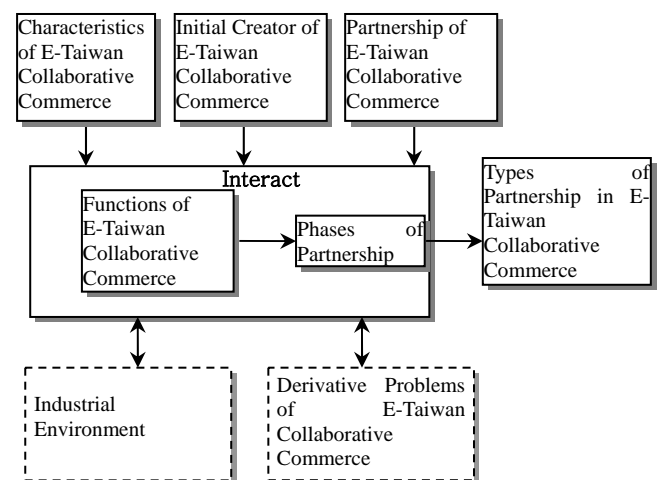


Figure 1. Research Model

Table 4. Crucial Influencing Factors of Partnership in E-Taiwan Collaborative Commerce

Phase	Selecting of Partners	Developing of partnership	Maintenance of partnership
Factor	credibility	ability of improving transaction quality	information transparency of capability of information integration
		information sharing	ability of improving for transaction quality
		ability of communication	information sharing
			ability of communication of cost reduction
		exceptional management	exceptional management
		security	trust
			e-business capability
			standards setting

V. Conclusion

The research findings have been shown the influencing factors are not the same in three phases of partnership in E-Taiwan Collaborative Commerce. These factors are dispersed in different dimensions as Figure 1. The research findings imply to manage a Collaborative Commerce must have different strategies to select, develop, and maintain participants. As to the prospective relationship style of partnership in E-Taiwan Collaborative Commerce, experts involved in the questionnaire survey suggest partnership maintaining is better for Plan A and Plan C; partnership maintaining or integration of value chain are two possible forms for Plan B; Arm's length, partnership maintaining or integration of value chain are three possible forms for Plan D and Plan E.

Due the scope of E-Taiwan Collaborative Commerce, small size of purposive sampling is the limitations of this research. Also path analysis is being applied to find the

relationship among these dimensions for providing administrators of Collaborative Commerce some detailed information for controlling and decision makings.

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A Proposed Model of the Effects of IT Diffusion on Organizational Absorptive Capacity and CRM Innovation Success

Ja-Shen Chen* Russell K.H. Ching** Leonardo Legorreta***

*Yuan Ze University 135, Far-East Rd., Chung-Li, Taoyuan, Taiwan

Phone: 886 3 4638800 ext. 2633 FAX: 886 3 4630377 jchen@saturn.yzu.edu.tw

**California State University, Sacramento 6000 J Street, Sacramento, CA 95819-6088 USA

Phone: 1 916-278-7197 FAX: 1 916-278-6489 chingr@csus.edu

***California State University, Sacramento 6000 J Street, Sacramento, CA 95819-6088 USA

Phone: 1 916-278-7120 FAX: 1 916-278-6489 legorret@csus.edu

Abstract: Business to customer (B2C) e-business has opened many new opportunities for businesses. In response to studies that underscore the importance of maintaining strong and learning relationship between the organization and customer, many have turned to customer relationship management (CRM) to manage their interactions with their customers and other external entities. Although IT enables CRM, other organizational factors, such as organizational absorptive capacity's effect on innovativeness, may have greater impact on its ability to continually satisfy the business' customer needs and expectations. However, IT may be a critical element to both absorptive capacity and innovation. This study examines the relationship between IT diffusion, organizational absorptive capacity and innovation, and proposes a research model. A clearer understanding of these relationships will provide businesses a means to appropriately direct their investments in IT and absorptive capacity.

Keywords: Customer relationship management, absorptive capacity, information technology diffusion.

I. Introduction

In recent years, businesses have begun transitioning to e-business models and consequently engaging in customer relationship management (CRM). Information technology (IT)-enabled e-business has opened many new opportunities for business organizations, yet reaping the rewards of these opportunities has required them to adopt more advanced IT-enabled means. In contrast to their traditional markets and business models (i.e., brick and mortar business models), many businesses are finding themselves immersed in highly competitive, consumer driven global markets conducted over the Internet, and competing against virtual alliances, organizations that collectively work together in either horizontally or vertically integrated partnerships that are facilitated by IT. Continual advances in IT have fueled this drive in competitiveness to new heights, and in cases such as the airline industry [13], have changed the way business is conducted. Thus, IT has not only changed the competitive landscape, but it also requires businesses to seek innovative

IT-based solutions to better leverage themselves.

On the consumer side, the market potential is enormous. For 2008, Jupiter Research forecasts that half of the US population will purchase their goods and services online through the Internet (versus 30 percent in 2004) and the estimated spending per buyer will average \$780 (versus \$585 in 2004); this translates to \$117 billion in sales. In contrast, Forrester Research predicted that online retail volume for 2004 would reach \$100 billion. Yet, profiting from electronic marketplaces will require businesses to become highly knowledgeable of their environments and customers. Thus, competitive threats and market opportunities are driving businesses to intelligently innovative applications of IT to ensure their longevity and survival. Market demands and expectations make IT a necessary resource to effectively compete, especially in global electronic marketplaces.

Business to customer (B2C) e-business poses several new challenges to businesses. The shift from mass marketed to micro-segmented, tailored products and services has forced businesses to establish and build closer learning relationships with their customers. As a result, many have turned to customer relationship management (CRM) to manage their relationships and interactions to gain greater insights into their (customers') needs and expectations [35]. However, their success with CRM lies in their ability to continually innovate to meet changing market conditions and customer needs, and gain competitive advantages through products and services that cannot be easily duplicated, imitated or substituted [29], [44]. This implies that businesses must be capable of not only learning from the entities of their external environment (i.e., customers, suppliers and other sources of information), but also to be able to leverage and exploit their organizational knowledge to innovate. Thus, conceptually, CRM's success hinges on how well the business *absorbs* pertinent information about its customers and applies the knowledge it has gained toward developing products and services that closely fit their needs and expectations. An organization's absorptive capacity, the ability to recognize and assimilate information and apply its cumulative knowledge toward a profitable gain [11], defines this ability.

Yet, the ability to innovate may not sufficiently meet the demands of highly competitive markets. The *speed* at which electronic markets operate becomes the underlying concern.

A common definition describes CRM as a process that utilizes technology to capture, analyze and disseminate current and prospective customer data to develop deeper and more insightful relationships, and identify and more precisely target products and services to specifically match their customers' needs [30], [35]. Thus, IT assumes a critical role in CRM performance since it may boost the business' abilities and subsequent productivity (*speed*). However, Grover et al. [19] cite inconsistencies in the results of studies that have examined the effects of IT investment on productivity do not lend an overwhelming endorsement to the relationship between IT investments and productivity (i.e., IT investments increase productivity) and suggest the presence of an intervening variable, perceived process change. Their study suggests that perceived process change's mediating effect on the relationship between IT investments and productivity (i.e., requires process change) is stronger and more consistent than its moderating effect (i.e., enables process change). This indicates that IT must be coupled with other organizational changes for it to have a desired effect on productivity. They recommend further studies to explore the relationship. Therefore, *to what degree does IT contribute to an organization's CRM performance in terms of its absorptive capacity and innovative output (i.e., products and services)? Do greater investments in IT lead to higher levels of organizational absorptive capacity and innovative output?*

The purpose of this paper is to propose a model of IT diffusion's effects on an organization's absorptive capacity and innovation, and examine the relationship between them in the context of CRM performance. IT diffusion refers to the acceptance and adoption of new IT solutions implemented for purposes of gaining competitive advantage. Given that the primary purpose of implementing CRM is to gain unprecedented competitive advantages and all businesses strategically position themselves differently, all businesses will apply CRM differently to produce different results (i.e., product and service differentiation). However, its performance as measured in organizational and customer relationship benefits should reflect the *return* on its investment, the number of successful (i.e., profitable) innovations over the amount of knowledge collected. This study proposes that greater investments in IT as captured through IT diffusion will not only increase organizational absorptive capacity, but will also allow the business to reap greater benefits from CRM and provide more tailored innovative products and services to their customers. Thus, IT influences the effects of organizational absorptive capacity and CRM performance. Absorptive capacity will be examined in terms of its ability to leverage and exploit organizational resources in contributing to CRM success. Understanding these relationships will provide businesses a means to direct their investments in IT and absorptive capacity.

II. CRM, Innovation and Absorptive Capacity

CRM is commonly recognized 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. It allows an organization to listen to its customers and customize its products and services to meet their personal needs [29], [30], [35], [44]. In consumer-driven markets where switching frequently occurs, successful businesses must be able to act quickly to seize opportunities through well-developed processes, maintain a wealth of information on their customers that is readily accessible, accurate and current, and leverage and exploit their knowledge and resources to sustain their competitive edge. CRM represents an IT-enabled system designed to meet these requirements. Experience suggests that a well-designed and implemented CRM will help ensure the longevity of a customer-business relationship, and enable the business to thrive in a consumer-driven market through such means as loyalty and (high) switching costs.

Often referred to as one-to-one marketing and relationship marketing, CRM allows organizations to individually focus on their customers rather than mass-marketing their products and services to broadly defined market segments [30]. It places emphasis on retaining existing customers [29] through such means as loyalty [26] since the greatest leverage comes from investments in retention rather than the generation of new customers [44]. Winer [44] cites a 1999 McKinsey study that strongly suggests repeat customers can generate over twice the gross income as new customers. Similarly, Reichheld and Sasser [32] reported that a 5 percent increase in the customer retention rate can lead to increases of 35 to 95 percent in average customer lifetime value (i.e., net present value of a customer). A survey conducted of 300 business executives underscores the importance of maintaining good customer relationships. It revealed that a one-point increase in an organization's customer satisfaction index (based on annual surveys conducted by the University of Michigan, the American Society of Quality and Arthur Andersen) corresponded to an average \$240 million increase in market (equity) value [40]. Building loyalty among existing customers often leads to increases in repeat-purchase rates and usage frequency, and raises barriers of entry into the markets as it makes it difficult for new businesses to court customers of established competitors [37]. Furthermore, the cost of acquiring new customers may be five times greater than that of satisfying and retaining current customers [31]. The Boston Consulting Group estimated that it costs a business \$6.80 to market to an existing customer via the web versus \$34 to acquire a new customer (via the web) [20]. Yet, building a long-term relationship involves more than innovating new products and services to meet the customer's needs. It also means delivering quality and value [21]. Given these rewards, it behooves most businesses to carefully plan, develop and invest in their CRM systems. Thus, the investment in relationship management can yield enormous and continuous returns; small increases to the number of repeat customers

frequently equate to large increases in profitability. Much of this success can be attributed to advances in IT that have allowed businesses to collect, retain and analyze customer data, gain greater insights into their customers' behavioral patterns, and innovate.

Effective investments in CRM and continual innovations increase customer switching costs through added value and trust [45]. Added value comes from the business' understanding of its customers' needs and targeting them through customization, one-to-one interactions, relevant promotions and information, and rewards and incentives. Each of these increases value since they may not be readily obtainable from other businesses. For the customer to receive the same benefits elsewhere, he/she would need to build another relationship. However, this would require the customer to entrust his/her personal information with an entity he/she may know little of. Consequently, the time involved with developing a new relationship will depend upon the pace at which the organization gains the trust of the customer. Furthermore, the customer must make investments in time and effort to convey his/her needs and personal information to the new organization. Therefore, the customer incurs several costs with switching. If the business maintains a healthy relationship (i.e., loyalty) and continually satisfies its customers' needs (i.e., does not provide the customer with reasons for shopping elsewhere), the cost remains high to the customer. Thus, continual innovation becomes a key factor in keeping switching costs high.

Innovation reflects the business' ability to understand its customers' needs, and leverage and exploit its knowledge into products and services. Thus, innovation can be used as a measure of CRM performance and is essential to CRM success. A general definition of innovation presents it as the development and successful implementation of new and creative ideas [3], [15], [42]. It includes processes involved with the generation (i.e., search and discovery) and acceptance of new ideas, processes, products or services [17], [18], [23], [41]. Innovations characteristically yield new techniques that are most likely superior to the ones they succeed [17], and lead to the achievement of higher levels of performance [22]. Hence, they embody improvements. However, the propensity towards adopting the innovation lies in the perceived benefits that exceed those of alternatives [4] and the added value perceived through adoption [36].

Organizational innovation depends on the collective creativity of employees and three basic environmental components: the motivation to innovate (i.e., competitive orientation as manifested in the organization's vision and mission), availability of resources, and innovation management skills (i.e., management support and skills that nurture creativity) [3]. In the absence of these components, innovations will lag. An underlying motive is the perception of capitalizing on unexploited technological and economic opportunities, and involves uncertainties (and consequently risks) in search activities and outcomes [17], [24]. Thus, economic gain or reward often accompanies innovation with

risks. Yet, the success of innovating products and services requires critical investments in the accumulation of knowledge [23], [24]. For this matter, Kanter [24] characterizes innovation as being knowledge-intensive, and dependent on how well an organization configured its knowledge to create new knowledge [43]. As a resource to innovation, IT advances information discovery and knowledge management, and thereby reduces risks.

Although IT serves as an underlying (i.e., necessary) condition, it may not be sufficient to ensure CRM success. IT will facilitate CRM success, but as in the case of other IT-enabled systems, the presence of organizational elements and factors that will benefit from IT will affect CRM performance. Since a fundamental objective of CRM is to translate the individualism of its customers to an array of differentiated product and service offerings, a business must rely upon innovative product and service discoveries that are developed through both the exploitation and exploration of information. This implies that an essential success factor of CRM lies in organizational knowledge and the organization's ability to leverage and exploit it. Prior studies [8], [11], [22] suggest that an organization's ability to link its knowledge to its innovations depends upon its capacity to innovate, the ability to successfully adopt or implement new ideas, processes or products. Similarly, Cohen and Levinthal [11] contend that innovations are products of an organization's absorptive capacity, its ability to recognize and assimilate new information, and apply the ensuing knowledge to commercial ends.

Zahra and George [47] define absorptive capacity as "a set of organizational routines and processes by which firms acquire, assimilate, transform and exploit knowledge to produce a dynamic organizational capability" (p. 186). The four capabilities interact and build upon one another to create a dynamic capability that leads to other organizational capabilities, such as marketing and production. The organizational change it (dynamic capability) produces is often strategic in nature. Yet, absorptive capacity largely depends on precursory learning (within the organization) and the dissemination and integration of subsequent knowledge [11]. As more knowledge is accumulated, the organization's absorptive capacity grows as its ability to recognize and assimilate information expands. Greater frequencies of learning reinforce prior knowledge and increase the organization's capacity to retain new knowledge, which in turn yields the application of knowledge to new scenarios [9]. A mechanism (i.e., process) to disseminate and share this knowledge becomes critical to developing innovative competitive advantages [27]. Because absorptive capacity will vary from organization to organization, product and service innovation success will vary accordingly, and depend on the knowledge it leverages and exploits.

This study posits that businesses with greater absorptive capacity will not only be more innovative, but will also more accurately meet and satisfy their customer needs. As a result, CRM will better position them competitively. Therefore, differences in CRM performance may be attributed to

differences in absorptive capacity. However, the IT an organization adopts may critically influence its absorptive capacity or its innovativeness.

III. Diffusion of IT and CRM Performance

The diffusion of IT in an organization concerns the extent to which it is adopted (i.e., accepted), and assumes the introduction of an innovative use of IT [7]. Because IT enables CRM, its diffusion may determine the extent to which a business can compete. Based upon innovation diffusion theory, the acceptance of new IT (innovation) hinges on the assessments and adoption of potential adopters who subsequently determine the adoption behavior in others [34]. Individuals regarded as potential adopters engage in information seeking behaviors to overcome a perceived uncertainty. Upon examining an innovation they view as a possible solution, they form an attitude toward it which eventually leads to a decision to adopt (accept) and implement the innovation or reject it. Given the relationship between innovation characteristics and innovation adoption, five key perceptions will influence an adopter's decision to accept IT: compatibility (i.e., perceived consistency with existing values, needs and past experiences), relative advantage (i.e., perceived advantage or improvement over the former method or technology), complexity (i.e., perceived difficulty to understand and use), trialability (i.e., degree to which it may be experimented with on a limited basis), and observability (i.e., degree to which the results of adoption are visible to others) [34]. The perceptions of compatibility and complexity are consistent with Bandura's [5] self-efficacy beliefs (i.e., behavior modification) and Davis' [16] perceived ease of use while relative advantage lends support to Ajzen's [2] outcome beliefs and Davis' perceived usefulness constructs. Trialability and observability provide the opportunity for potential adopters to expose and demonstrate IT-use to encourage others. They will communicate through the organization's formal and informal social system their information to others who they influence. The study of Agarwal and Prasad [1] implies that the perceptions of early adopters (in contrast to non-early adopters) will have a greater impact on adoption. Therefore, carefully planning an adoption strategy will greatly enhance IT's successful adoption [12].

In their study of the effects of absorptive capacity on IT use, Boynton et al. [8] suggest that IT management climate strongly influences an organization's absorptive capacity. They define IT management climate as management's attitudes and perceptions of IT's role in the organization, and are reflected in its planning orientation, vision and control structures. Bannister [6] further states that IT leadership contributes to forming the IT management climate. As they apply to IT diffusion, IT leadership and management climate create an atmosphere and culture that promote and facilitate the introduction and adoption of IT, and the dissemination of information throughout the organization, all crucial to diffusion. Thus, their studies establish the positive

relationship between IT diffusion and absorptive capacity as IT diffusion supports higher levels of knowledge development and intelligence gathering. Other factors that influence the adoption of IT include organization culture, knowledge sharing and learning [24], [25], [46], norms and opinion leaders [34].

The diffusion and deployment of IT will be unique to each organization due to its characteristics, particularly its accumulated knowledge [7], [28]. The interpretation of information entering the organization is contingent upon the organization's ability to recognize and link new information to its stored knowledge. Its current technology base (and the knowledge of that technology base) initially influences its perceptions and determines whether an innovative technology is deemed appropriate and useful. Furthermore, an organization's absorptive capacity may promote IT use (i.e., the greater the absorptive capacity, the greater the IT use) [8]. Once assimilated, IT's adoption and use depend upon the focus of the organization's knowledge. Applying the technology to non-complementary applications (i.e., applications that do not converge on a common body of knowledge) rarely occurs due in part to the organization's bounded rationality; organizations will adopt solutions that fit within the scope of their knowledge [28], [33], [38]. Additionally, an organization's interpretation of efficiency directs its emphases on different aspects of knowledge and how it applies its knowledge. An organization's means for converting inputs to desired outputs (based upon its interpretation of efficiency) determines its capacity to plan, coordinate, control and monitor the diffusion of IT [28]. Therefore, the content of IT in CRM will differ among organizations. Largely, it depends on the extent to which diffusion (i.e., adoption) has occurred, as determined by their focus and knowledge. This suggests that IT will facilitate absorptive capacity since IT will influence the development of absorptive capacity as it (IT) focuses the organization's intellectual resources toward achieving higher levels of performance (i.e., researching and developing innovative products and services) in specific areas of CRM. Hence, IT diffusion plays an important role in determining the extent to which new knowledge can be *absorbed* into the organization. The underlying goal is to create an environment of continual innovation.

IV. Proposed Model of IT and CRM Performance

A business' absorptive capacity plays a critical role in determining its CRM performance. The information the business learns from its customers and about pertinent market conditions will become part of its knowledge (through assimilation), which will eventually drive the innovation of products and services that directly target its individual customer's needs. To sustain its competitive position, its knowledge must also incorporate a sense of perceived benefits and added value over alternative offerings,

and featured qualities that cannot be easily duplicated, imitated or substituted. Continual innovation to meet these requirements and others imposed by changing market conditions requires continuous learning and knowledge accumulation. As more knowledge is amassed, the business' power to accumulate further knowledge and more precisely direct its innovative activities becomes greater. In this study, CRM performance will be based on the business' innovation output, and success can be tied to the organization's ability to leverage and exploit its knowledge with IT providing the means (for leveraging and exploiting it). As in the case of Cohen and Levinthal [11] and Stock et al. [39], the number of products and services produced through CRM can therefore reflect the organization's absorptive capacity. In the absence of organizational absorptive capacity, IT alone will be incapable of supporting CRM.

The proposed model of this study embodies the dynamic capabilities of absorptive capacity and their interrelationships [47]. In examining the relationship between IT diffusion and CRM performance (i.e., IT's contribution to CRM performance), this study proposes that organizational absorptive capacity mediates (i.e., require process change) the effects of IT diffusion on innovation. A mediating effect suggests that IT diffusion enhances the effects of organizational absorptive capacity on innovation (Figure 1), similar to the study of Boynton et al. [8] on the effects of IT management climate on absorptive capacity, and the ensuing effects of absorptive capacity on IT use. For IT diffusion to have an impact on innovation, IT-enabled process changes in absorptive capacity must occur among its capabilities. This may include devising new ways in which opportunities are recognized, information is acquired, assimilated and transformed, and knowledge is exploited. As a result, the effects of IT may amplify or enhance the effects of organizational absorptive capacity on innovation. Greater levels of IT investments within limits [39] may lead to higher levels of absorptive capacity and consequently a greater number of successful innovations (i.e., successful CRM performance) if process changes occurring in absorptive capacity take advantage of the investments.

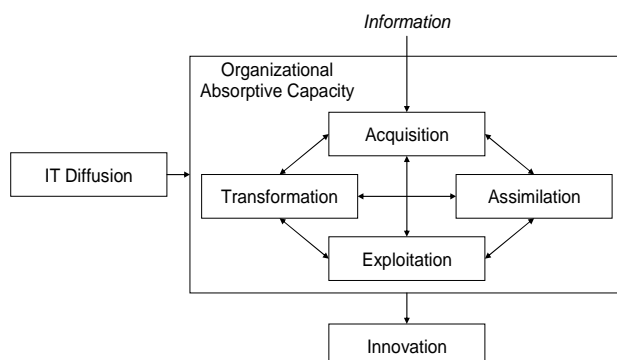


Figure 1. Proposed model with IT diffusion's mediated effect on innovation

Because IT enables CRM, its (CRM's) success hinges on how well the business has adopted innovative applications of

IT to maintain its IT sophistication throughout the organization. In dynamic global markets, changes can occur quickly and suddenly due to advances in IT. As new technologies become available, businesses must learn their benefits and examine ways in which their adoption can provide a distinct competitive advantage. If these advantages become apparent and supportive of the business strategy, the adoption of the technology must quickly be disseminated throughout the organization's work processes and activities. However, these advantages are often only short-term. As the technology becomes readily available, its mass adoption throughout an industry overcomes the advantages. Thus, the search for new technologies continues and IT diffusion becomes critical to a business' long-term profitability. Currently, innovations in network infrastructure, client-server computing and business intelligence application are leading IT factors in CRM development [10] that will benefit a business with their timely adoption. To ensure the quick adoption, the organization must have in place channels or an organization structure (i.e., social network) conducive to diffusion.

In CRM, the discovery of knowledge is a major component to its success. The business must focus on increasing customer satisfaction and loyalty through the information it acquires through its one-to-one relationships with customers and learns of market trends and other environmental factors that will impact future customer needs and expectations. IT can be used to quickly access information, retain volumes of data for future analysis, assess markets and transform the information it gains (i.e., data analysis) into knowledge. In electronic marketplaces, the speed and sophistication of knowledge discovery is a critical element. Absorptive capacity represents the learning and knowledge building component of CRM and relies upon IT for the discovery of new and retention of existing knowledge. Thus, IT diffusion leads to the introduction and adoption of new tools or processes that will benefit the *absorption* of new knowledge, leverage and exploit the organization's knowledge, and consequently seize opportunities and provide a competitive advantage. Prior studies have shown IT development supports higher levels of knowledge development and intelligence gathering [6], [8]. Hence, IT enables absorptive capacity.

Proposition 1. *IT diffusion will have a positive effect on organizational absorptive capacity.*

The purpose of building absorptive capacity is to leverage and exploit the organization's knowledge towards a commercial end [11]. It involves the business identifying its customers' buying behaviors and habits with granularity, integrating this information into an existing body of knowledge, discovering new knowledge from the information it has gained and applying its knowledge to innovate products and services that more precisely meet its customers' needs, preferences and expectations, thereby increasing their switch costs through quality and value not readily obtainable elsewhere, and providing at least a

perception of superiority or achieving a higher performance level. These innovations should possess a uniqueness that competitors cannot easily overcome and find difficult to imitate, duplicate and substitute the product or service to gain a competitive advantage. Internally, innovations may include improved processes or methods for customizing or delivering the products or services. Given these characteristics, innovativeness is knowledge-intensive. By continually applying what it learns from its customers, the business will ensure the longevity and benefits of their relationship. Thus, the greater the resources that are committed to developing absorptive capacity, the greater the capacity of the organization to innovate and reap greater benefits from CRM (i.e., improved operating performance, customer retention, loyalty and satisfaction, repeat transactions, market share and opportunities, etc.); absorption capacity enables innovation.

Proposition 2. *Organizational absorptive capacity will have a positive effect on innovation.*

Prior studies indicate that IT has no direct effect on productivity [8] or CRM impact [14]. Instead, another factor will mediate its effect. A mediating effect occurs when variations in the independent variable account for variations in the mediator (i.e., intervening variable), variations in the mediator account for variations in the dependent variable, and when controlled the independent variable has no effect on the dependent variable. Hence, IT's effect on innovation must be mediated by an intervening variable; this study proposes absorptive capacity. Although IT diffusion opens opportunities for the expansion of innovations, IT by itself cannot be directly linked to innovativeness since it represents only a means (tool) for discovery. Yet, the development and expansion of knowledge in the form of absorptive capacity benefits from IT diffusion (i.e., proposition 1). In turn, increases in an organization's absorption capacity will lead to higher levels of innovations (i.e., proposition 2). The research model presented in this study proposes that innovations will benefit from IT diffusion if it targets knowledge development (i.e., absorptive capacity), a key element to innovations. If absorptive capacity is a mediator, IT diffusion will not have a direct effect on innovation, as suggested by prior studies. In this study, innovations reflect CRM performance as they are a result of CRM use in leveraging the organization's knowledge.

Proposition 3. *Organizational absorptive capacity will mediate the effects of IT diffusion on innovation.*

The purpose of the proposed model is to examine the roles IT and absorptive capacity play in the innovations aspect of CRM performance. In the ever-changing global electronic marketplace, a business' ability to continually innovate will contribute to its longevity through customer satisfaction and loyalty.

V. Practical Business Implications

In the past years, businesses have increasingly invested in CRM. Yet, according to the Meta Group, several implementations have either failed to go live (25 percent) or fallen short in meeting expectations (59 percent). AMR Research indicates only 16 percent are considered complete successes. This is in spite of the \$10.8 billion it estimates American businesses have invested in CRM software and services during 2004, a \$1 billion increase over the previous year. Although many of the failed endeavors have been traced to business change and adoption imposed by the new system, Forrester Research suggests successful CRM implementation have focused on delivering customer experiences.

Understanding the needs, preferences and expectations of customers with the goal of retaining them in long-term relationships is paramount to CRM. The competitive edge goes to the business that cannot only acquire the essential information containing customer buying habits and preferences but can profitably leverage and exploit the ensuing knowledge in a very timely manner. This suggests three implications to practice: IT should facilitate communications between the business and its customers and within the organization, businesses need to focus their investments in absorptive capacity on long-term innovative discoveries, and diffusion plays importantly to ensure the timely adoption of IT that will benefit the previous two implications.

Meaningful interactive communication is vital to building relationships in relationship marketing (RM) and CRM. It enhances the customer's experience by providing the business with information that will be used to target customer satisfaction and the customer with products and services that reflect his/her preferences. The particular value and benefits the customer derives from these offerings increases his/her switching cost through increased satisfaction, thereby raising uncertainties with patronizing another business. The more effective and efficient the means for fostering or facilitating the communication between the business and customer is, the greater the impact the communications will have on the business' absorptive capacity development. Communication within the organization and between the business and its partners (i.e., suppliers, distributors, etc.) ensures the business will benefit from its knowledge, alerts the business to shifts in its markets and helps expand its organizational knowledge. IT provides the means for delivering knowledge as a shared resource through a technical infrastructure and communication networks.

Because the development of absorptive capacity embodies a continuous learning process, investments in it should focus on the long-term discoveries of innovations. To maintain its long-term relationships with its customers, the business must continuously seek new products and services that they can recognize and associate with value and benefits. These innovative offerings will result from established learning relationships that feed an accumulated body of

knowledge. Innovations also involve new processes, such as the delivery of information, or products and services, that improve and enhance the customers' experiences. IT provides the means to quickly recognize new opportunities, accumulate and disseminate knowledge, and maintain the learning relationships.

Lastly, the diffusion of IT supports the business' CRM endeavors in communications and absorptive capacity. Competitive market forces play a major role in the adoption of IT, particularly those which provide a distinct competitive advantage. Enhancements to communication come with the adoptions of newer technologies, such as wireless devices that support mobile commerce (m-commerce) or ubiquitous commerce (u-commerce), and web technologies. Advances in IT have made data repository capacities in the terabytes common and data warehouses the focal points of business intelligence. The medium on which data are transported now supports transmission speeds in the gigabytes. Together these have opened new possibilities to enhance the customer experience (e.g., on-demand streaming video, personalized and customized products and services, etc.) and the diffusion of IT has become more crucial to the business' ability to leverage and exploit its knowledge to effectively compete in global electronic marketplaces. Because e-business requires the business and its partners to work as one to project a single image, an organizational structure and channels to ensure the rate and degree to which IT becomes embedded in processes and activities are important.

VI. Summary

The movement toward B2C e-business opens many new challenges to business organizations. Competing in highly competitive and consumer-driven markets has shifted business emphases from mass marketed to micro-segmented, tailored products and services that target the specific needs of customers. As a result, many businesses have turned to CRM to establish closer learning relationships with their customers and gain a greater understanding of serving them in hopes of building their loyalty and increasing their switching costs. However, CRM performance must be gauged by the business' ability to continually innovate products and services while remaining competitive. An organization's absorptive capacity becomes a critical element as it assimilates customer information (along with other information) and further leverages and exploits the organization's knowledge. Organizational absorptive capacity in turn forms the basis for innovations. Rapid changes and unexpected shifts in market expectations place additional demands on CRM to innovate quickly. Thus, the adoption of innovative IT may help in leveraging the organization's absorptive capacity. However, the effects of IT diffusion on absorptive capacity and innovation are uncertain. This study proposes the development of a model to further examine their relationships.

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A Customer-Support Knowledge Network Integrating Different Communication Elements for an E-Commerce Portal Using Self Organizing Maps

Tapati Bandopadhyay & Pradeep Kumar

ICFAI Business School, IDPL Complex, Old Delhi Jaipur Road, Dundaheera, Gurgaon (Haryana) 122016, INDIA

Phone : 91-124-2455485

Fax : 91-124-2455484

pkgarg@ibsdcl.org , tapati@ibsdcl.org

Track Area

Customer Relationship Management

Correspondence Author

Pradeep Kumar (pkgarg@ibsdcl.org)

Abstract: Successful e-commerce portal organizations focus intensely on customers. They try to consider every bit of information that flows from the customer to their system as an input for analyzing and identifying their needs precisely and catering to them. Being mostly 'click and mortar' or completely e-enabled, they have a lot of operational flexibility to address customer requirements in a more personalized and customized way than their brick-and-mortar counterparts with more operational rigidity and resource constraints.

Managing diverse range of channels is a challenge because of exponential and sometimes disruptive growth of diverse technologies that are used for supporting high-volume e-commerce operations. Customers are bouncing between phone, email and the web with greater fluidity than ever and therefore, fragmented, 'stove-pipe' communications, in such situations, can create problems as they lose out the holistic view on the basic nature of the problems and customer priorities. Therefore, the use of a common knowledge base across all channels is a dire necessity for an e-commerce portal, especially the ones which do not have a 'brick-and-mortar' back-end. The customer-support knowledge network as proposed in this paper addresses these issues. Using Self Organizing Maps(SOM), the network becomes incrementally self learning representing various groups of communication instances at any point of time. The advantages include the integration of all communication elements and an assimilation of all the customer communication issues into a reusable form of self-learning network. It adds an immense value for a customer-focused e-commerce company for identification of generic issues, better understanding of customer concerns and priorities and designing products/ services/ promotions accordingly, to ensure an overall better success of business.

Keywords: Self Organizing Maps(SOM), Customer Relationship Management (CRM), E-Commerce, Knowledge Network.

I. Introduction

I.1 Importance of Effective Customer Communication-Based Knowledge

Successful e-commerce organizations treat customers as the only way of their survival as well as gaining competitive advantage. They focus intensely on customers, creating customer profiles, designing promotions and offers focusing onto particular customer segments and online communities. They try to consider every bit of information that flows from the customer to their system as an input for analyzing and identifying their needs precisely and catering to them. Being mostly 'click and mortar' or completely e-enabled, they have a lot of operational flexibility to address customer requirements in a more personalized and customized way than their brick-and-mortar counterparts with more operational rigidity and resource constraints. Big e-commerce portal companies like Yahoo and Amazon.com invest heavily in systems like CRM (Customer Relationship Management), processes and often in capturing inputs also to improve their products and provide better services. They focus on retaining customer loyalty as well as on attracting new customers. In Roffey Park research (2004), high performance has been shown to be strongly correlated to customer-focused purposes. Internally also, a significant high proportion of employees in HPOs think that their organization is highly customer-centric or even customer-driven. So, ignoring customer needs can be completely detrimental to sustainable growth of any organization. The most effective vision for change is customer focus. [3].

To achieve customer focus, one of the crucial and valuable sources for any company is the customer communication. It is all the more important for e-commerce portals which often do not have any backend brick-and-mortar interface for handling customer communication, and thereby consequently have to manage a diverse range of communication channels for customer interfacing. Most of the e-commerce or e-business portal companies have a lot of ways to gather customer feedback, e.g. through online chatting with a support-resource, or through e-mails or form-based interfaces on the net, because it gives the customer the flexibility to communicate in an asynchronous

domain (which is not the case with the telephone calls) and also gives them a platform to communicate in writing which is a more convenient way as perceived by people for putting the problems or thoughts in a more structured fashion. Also it reduces the anomalies in understanding as everything is in writing, and it also helps the customer or the company to keep a track of the communication that has taken place for example in terms of a series of request-response mails. Even in case of e-commerce-based companies which completely rely on digital medias for customer interfacing, customers communicate in a variety of ways. These are usually mentioned and supported as the communication channels between the customer and the company in the company website, e.g. the contact email_ids, the phone numbers or online forms. So, consequently, the customers call. They send email. They visit web sites and use the self-service portal facilities or chat services or online complaint register forms etc. Managing each of these communications channels as effectively as possible is a real challenge. It has now become even more critical to manage these channels collectively, because, with the exponential and sometimes disruptive growth of diverse technologies that are used for supporting high-volume e-commerce operations, customers are bouncing between phone, email and the web with greater fluidity than ever. They send emails about problems that they have already discussed by phone, and then visit the web site to double-check the information they received on the phone. Fragmented communications, in such situations, can create problems. The portal's service representatives get blindsided by calls from frustrated customers. They repeatedly answer redundant questions, as they do not have any unified or holistic view of all the communication instances of the same customer on a same issue. Neither can they easily add new knowledge items to the web site or the portal's back-end knowledge resources. Worst of all, e-commerce companies with "stovepipe" communications channels e.g. isolated calls, email and web self-service systems can not adequately understand or address customers' top service issues, because they lose out the holistic view on the basic nature of the problems and customer priorities. Use of a common knowledge base across all channels is therefore a dire necessity for an e-commerce portal, especially the ones which do not have a 'brick-and-mortar' back-end equipped with actual people or real human faces to interface with the customers. The business impact of this unified approach is substantial. A unified knowledge network for managing customer responses can deliver competitively superior service at dramatically reduced cost, because each channel becomes more efficient and, over time, more and more customer interactions are driven to the least expensive and most scalable channel that is the web. This also provides companies with clearer insights into their customers' top concerns. These insights are enormously helpful for improving customer care, driving the development of successful products, promotion schemes, special offers focusing on particular customer segments and services, and formulating high-impact marketing strategies.

I.2 The Customer-Support Knowledge Resources

When an e-commerce portal handles customer interfacing in a stove-piped situation:

- The phone channel is managed by a call center platform.
- The email channel is managed with an email management system.
- The web channel is managed with a content management system.
- Chat, if provided at all, is managed by a chat system.

All these systems, when disconnected, on heterogeneous platforms without any integration, communication or sharing, create information/ communication islands of their own without any connecting road-maps. So, naturally, the portal company tries to manage each of these communications channels as effectively as possible. But it has now become critical to manage these channels collectively. That is primarily because customers are bouncing between phone, email and the web with greater fluidity. Any interaction with a customer on one channel is completely divorced from any other interaction with that same customer on any other channel, because the interactions do not flow down to any common knowledge repository. When customer service representatives (CSRs) are on the phone with a customer, they have no idea what that customer's emails looked like. The information that a customer gets in an email may not exactly match the information on the company's web site. Each channel is isolated from the others—to the detriment of both the company and its customers. Subsequently, the problems that companies and their customers experience every day because of stovepipe communications channels are exemplified in situations as described below:

- The "Didn't you see my email?" syndrome

A customer with a problem takes the time to carefully describe that problem in an email message and then calls for a follow-up. The support person taking the call has no clue of the original email exchange. So instead of just asking a follow-up question, the customer has to explain the whole situation all over again. The customer gets annoyed, the CSR spends an unproductive time.

- The endless repetitive calls syndrome

Companies with conventional "stovepipe" customer communication channels have great difficulty developing effective self-service content for their web sites. When the support representatives encounter a new support issue, they have no fast and easy way to *capture* that issue and *publish* it as a knowledge item on the web. So instead of answering questions only once on the phone and then having them answered automatically in the future with relevant online knowledge items, "stovepipe" communication channels answer the same questions over and over.

The overall negative business impact of these problems can be that inconsistent information can be provided by each channel and customers are more frequently annoyed,

angered and confused. "Stovepipe" channels also deprive companies of insight into the issues that most concern their customers. It is difficult to get that insight if the company can not get a holistic view of customer interactions i.e. they can not look at communications activity across all of the customer service communications channels.

I. 3 Customer Communication Elements

Customer communications with an e-commerce portal can be broadly classified into following categories based on the purposes of communication:

- Enquiries e.g. on new products/ services/ schemes
- Feedback.
- Complaint
- Support

There are also the various ways customers communicate to the organizations using technology/ media combinations at different levels of complexities. From Figure 1, it can be derived that the customer input/ feedback sources are not only varied in terms of their use of various channels or media, or their degree of structured-ness and unstructured-ness, but also in terms of the underlying technologies like the communication domains, which also encompasses the network elements, the server technologies, data repositories like warehouses or operational RDBMS.

Using all possible combinations of these varieties, capturing customer knowledge from these combinatorial resources in a unified form is a daunting task. The ideal situation in this case would be as shown in Figure 2:

This is precisely the solution that we are proposing in this paper. Towards this end, we have first developed a generic process model, explained in the next sections, based on SOM for dynamically gathering communication inputs from all channels and then converting them into a knowledge network based on the unsupervised learning mode of the neural networks.

I. 4 Existing Tools and Techniques to Capture Customer Communication

Generally, in the context of capturing knowledge or discovering reusable patterns from customer inputs, data mining, pattern recognition techniques have been abundantly used. Data warehousing and on-line analytical processing (OLAP) have typically been used to solve data extraction, transformation, data cleaning, storage, and mining issues. Regarding handling of natural-language based unstructured information sources; previous efforts have used document-based technologies and supported document-level functions such as full text search, document classification, and so on. Business practitioners have developed automated tools to support better understanding and processing of information. Researchers have also developed advanced analysis and visualization techniques to summarize and present vast amount of information. [4] Despite recent Improvements in analysis capability [4], there is still a long way to go to assist qualitative analysis effectively. Most tools that claim to do

analysis simply provide different views of collection of information {e.g.. comparison between different products or companies}. Lin [8] identified various display formats for handling multi-dimensional data e.g. hierarchical displays- an effective information access tool for browsing, network displays, scatter displays [10]. There are other methods for document representation and visualization also which primarily concerns the task of getting insight into information obtained from one or more documents [12]. Most processes of document visualization involve three stages i.e. document analysis, algorithms, and visualization [10]. Web content mining treats a web document as a vector of weights of key terms [1]. He et al. [5] proposed an unsupervised clustering method that was shown to identify relevant topics effectively. The clustering method employed a graph-partitioning method based on a normalized cut criterion. This method we are using in this paper to extract knowledge from customer communication resources.

II. Creation of a Knowledge Web Using Customer Communication Elements

As explained in Figure 1 regarding various elements in customer communication, there is a need for integrating the knowledge captured from these communication resources. Customers sending mails or leaving voice messages are generating valuable knowledge assets. Voice recordings can be converted into text documents. Now, treating these text messages (source being emails/ form based text inputs/ voice messages converted) as unstructured documents, we can use co-occurrence analysis to find the similarities and then consequently the dissimilarities between the messages/ text contents. For this paper, herein after, we are using messages as the unit of customer communication and thereby are referring to any of the communication elements as messages. Messages which are very similar in terms of their contents i.e. many of the identified key-terms (i.e. Terms excluding the general terms like pro-nouns, prepositions, conjunctions etc.) are same, can be clubbed up together to form a cluster. Dissimilar message/ text bodies can be created as other clusters. These clusters can then form a network using hierarchical and partitional clustering method to form a graph which we are mentioning in this paper as a Knowledge Web based on customer communications.

II. 1 Self Organizing Maps

In this paper, we are proposing a generic model for developing a knowledge network to integrate various customer interaction/ communication elements. This network is developed using SOM (Self Organizing Maps) proposed by Kohonen [6].

If we treat the customer communication resources broadly as textual (which most of them are, as is apparent from their description above in Figure 2, there are various classification schemes applicable to them. Most popular text-data classification techniques include clustering. There

are two main clustering methods: statistical and neural network approach. In the serial statistical approach, automatic text-data classification involves two processes: 1) a text representation structure, 2) a method to determine similarity between such text data. Once the class identification is done, the hierarchical clustering of text data can be done divisively or agglomerative. In divisive clustering, one cluster is further broken down into smaller segments, whereas in agglomerative clustering, a gluing operation based on the similarity between clusters takes place to form groups. There is also a method of conceptual clustering. [11]. Algorithms for clustering involve co-occurrence analysis for similarity measurements, discovering conjunctive features and clumping relationships based on most frequently occurring data, and then a pairwise comparison.

The neural network approach is a connectionist approach. Algorithms in neural networks are mainly parallel where multiple connections among the nodes allow independent, parallel, and consequently faster comparisons. These techniques are also of two types: supervised and unsupervised. In the supervised mode, a training data set is first presented in the training phase, based on which the network calculates the input weights, compares it with the desired output weights for a particular input, then derives the weights and minimizes errors incrementally. In unsupervised method, an input vector is given to the network. Through various network learning rules, these input vectors are analyzed for their statistical or similarity properties, and the network consequently dynamically adjusts the weights of each node forming in the graphical representation of the cluster. SOM is an unsupervised learning method for the neural networks. This is based on the associative properties concept of human brain functioning. The network contains layers like the input layer and the mapping layer in the form of a 2-D grid. The output layer can be thought of as a distribution layer. SOM has been applied successfully in many research efforts concerning document classification. Kohonen[6] applied this model for finding out logical similarities between words. Lin et al [7] used it for information retrieval. Orwig[9] and Chen [2] used it as SSOM or Scalable SOM to classify electronic brainstorming outputs.

We intend to use SOM developing a knowledge network with inputs from various customer communication resources as shown in Figure 2. These resources are to be extracted from heterogeneous sources i.e. mail servers, chat servers, IVR(Interactive Voice Response) systems, web-based forms, self-service portals etc. and then can be given as inputs to the knowledge network creation module. SOM appears to be a best candidate for choice in this context primarily because:

- Neural network methods being able to work in parallel can be much faster, provided adequate hardware resources are there, to handle complex, and voluminous text data resources, which is the typical case in the context of this paper, i.e. IS development projects.

- SOM in particular is an unsupervised learning method, so this can effectively self-enhance itself and keep the temporal consistency and integrity of communication elements i.e. can self-enhance based on the latest customer inputs

III. The Generic Model for Integrated Customer Communication-Based Knowledge Network Creation

This model takes all heterogeneous inputs from various sources as the inputs to the SOM module, as shown in Figure 3 below.

We explain this model with an example as below. Suppose a customer has bought a high-value electronic gadget from an e-commerce portal. The gadget has been installed but is not functioning properly. So, the customer has to communicate about this with the portal company. Suppose he/she makes the communication as follows:

- He/ she first tries the self-service facilities that provides information on trouble-shooting of that particular gadget. But, the customer does not succeed in solving the problem following the instructions or information that were given in the self-service portal.
- So, he/she calls up the portal's help-desk. An IVR complaint recording is done. The complaint_ID gets auto-generated by the IVR back-end and is given to the customer through the IVR system.
- The customer is worried because it is a brand-new high-value item. So he again calls for a follow-up. This time he chooses to speak to a service rep. He gives the IVR-given complaint-ID to the service rep.
- The service rep checks up on the status of the complaint handling process and gets back to the customer saying that it would be better if the customer could send a detailed e-mail on what is precisely the problem, as the voice recorded message is short and not fully explanatory.
- The customer sends a long e-mail explaining the whole problem in detail including his/her experience in trying to fix it by himself/herself using the self-service portal, and then giving reference of the same complaint-ID.
- The problem is sorted out next day when a mechanic visits, equipped with the necessary parts and tools.

Now, this sequence of communication has the following elements:

- A self-service session: can be identified by a transaction_ID on the log-file records of the portal.
- An IVR interaction and a voice-recorded message: identifiable with a complaint_ID
- A telephonic interaction with a service rep: identified and referred with the same complaint_ID
- An e-mail with the complaint_ID and referring to the transaction with the self-service portal.

According to the generic model, the unsupervised SOM-

based knowledge network module would take these inputs in an integrated fashion as follows:

- The network would receive messages from
 - the IVR back-end database,
 - the call recording
 - converted into digital contents using voice analyzer software,
 - e-mail messages from the e-mail server
 - transaction log-files from the self-service portal server
- The network will create the first level of clusters:
 - In the example case, first by locating the corresponding transaction_ID and associating it with the complaint_ID
 - Then by grouping the entire sequence of communication as:

CommunicationInstance[i] {Complaint_ID, [elements of communication]}

Otherwise, this primary clustering can also be based on:

- Customer_IDs e.g. for new product/ service queries/ promotions
- Query_IDs etc., depending on the purpose of communication which is explained in section 2
- This level of cluster would give an integrated view of all communication elements for a particular sequence or communication instance.
- Now, these communication instances will be fed into the SOM module for creation of a reusable customer communication knowledge network, the steps being depicted below:

- Collate all elements, say $\sum_{i=1}^N [E_i \dots E_j]$ from N

communication instances, over a time t

- group them by automatic parsing for a reference information i.e.
 - Class_reference numbers for complaint classes in the Complaint_IDs
 - Error/ exception no.s
 - Transaction IDs
- Create an input vector of N keywords for each group, e.g.:

GroupInstance1[reference index(Complaint_Class/ TxnID), string_of_terms_used (nouns(a..n), verbs(a..n), qualifiers(a..n),)]
- Input an initial group vector e.g. GroupInstance1 to the SOM module
- Initialize the input nodes, output nodes and connection weights: Represent each string as input vectors as shown above. Create a 2-D grid based on the N input vector elements and M output nodes.
- Input all the GroupInstance vectors for all the groups and the grid gets created by dynamically adjusting the weights to the input nodes based on the input vector string terms
- Compute distance between all nodes e.g. D_j between the input and each output node j as follows:

$$D_i = \sum_{i=0}^{N-1} (x_i(t) - w_{ij}(t))^2$$

where $x_i(t)$ is the input to node I at time t and $w_{ij}(t)$ is the weight from input I to output node j at time t.

- select winning node j^* (i.e. the node with the minimum distance) and update weights to node j^* and its neighbors based on reducing distances.
- Label the regions in the map identifying the typical group features.
- Go to step 1

The SOM network that is formed this way will become a self learning incremental knowledge network representing various groups of communication instances at any point of time t.

IV. Conclusion

There are two main advantages of this customer-support knowledge network for an e-commerce portal:

1. With the primary clustering, all the communication elements regarding one sequence or one problem are integrated. So, the problem of stove-piped communication is resolved.
2. With the knowledge network, all the customer communication issues are assimilated into the self-learning network in a reusable form, which again would add immense value for a customer-focused e-commerce company, for identification of generic issues, better understanding of customer concerns and priorities and designing products/ services/ promotions accordingly, to ensure an overall better success of business.

There are various possibilities of extending the premises of this paper like creating a knowledge network of support teams themselves and/or the support aspects of an organization.

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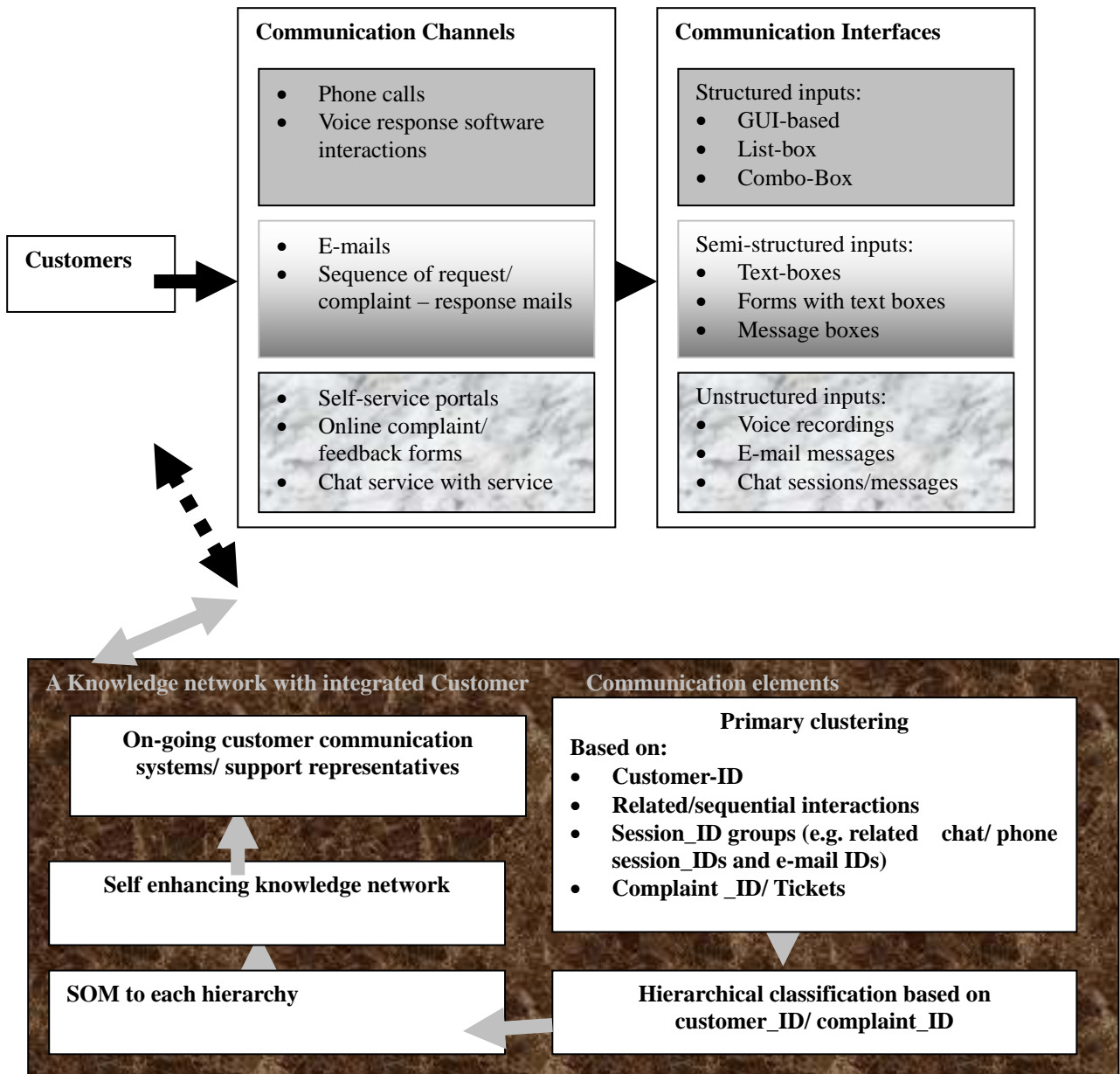


Figure 3: The generic model for customer communication knowledge network creation

A Study of Online Customer Loyalty Based on the Theory of Planned Behavior

Chi-I Hsu¹, Bing-Yi Lin¹, and Chaochang Chiu²

¹Department of Information Management, Kainan University, Taiwan, R.O.C.

²Department of Information Management, Yuan Ze University, Taiwan, R.O.C.
imchsu@mail.knu.edu.tw; m93221001@ms2.knu.edu.tw; imchiu@im.yzu.edu.tw

Abstract: The Internet has introduced major changes in the way companies conduct business. Practically, rising numbers of customers are using the Internet for Electronic Commerce (EC). In the respect of customer relationship, Business-to-Consumer (B2C) EC provides ongoing information, service, and support that have changed the approaches of communication and interaction with customers. The nature of online customer behavior in the EC transaction is therefore different from the one in a traditional retailing channel. This research focuses on the online customer behavior through examining the relationship between the behavior intention and the online behavior itself. Based on the Theory of Planned Behavior (TPB), a base model of Online Customer Loyalty is developed. The research also proposes an alternative model in which Satisfaction is adopted as a mediated variable. Four hundred and twenty-three questionnaires are collected for the empirical experiment. The method of Structural Equation Modeling (SEM) is used to evaluate the measurement and structural models. The result indicates that TPB can be used to explain the behavior of Online Customer Loyalty. The structure relationship between Behavior Intention and Online Customer Loyalty is significant. The three constructs influencing Behavior Intention including Attitude toward Behavior, Subjective Norm and Perceived Behavioral Control also have indirectly positive effects on the behavior of Online Customer Loyalty. The two competing models are compared. Both models are acceptable when judged by the criteria of goodness-of-fit measures. However, the alternative model has a higher explained proportion of variance in Online Customer Loyalty.

Keywords: Customer Relationship Management (CRM), Electronic Commerce(EC), Theory of Planned Behavior (TPB), Structural Equation Modeling (SEM).

I. Introduction

The Internet has been applied in different kinds of commercial activities, among which Electronic Commerce (EC) is the one best providing a close contact between customers and business owners. The commercial competition is thus extended from physical market to online marketplace [37]. Consumers can use the Internet to watch all kinds of digital catalogues and multimedia product information. Through the more convenient product searching

function and virtual shopping feeling, B2C EC model is becoming more acceptable to customers. B2C websites can not only provide the introduction of products and the company, but also the real-time information. The website design emphasizes on the personalization and interactive nature, and the function providing customers with online order and payment has also been added to it.

Along with the vigorous development of EC, many businesses from the traditional market have begun to involve in the virtual electronic market; however, there are discrepancies of certain degree existing between the consumer behaviors of these two markets. Further, the shopping environment is facing a competitive situation even much keener than ever due to the rising trend of the Consumer to Consumer (C2C) personal online sales. Thus, understanding the behavior model of online customers to develop a most advantageous managing model is the key factor leading to the success in today's customer-oriented relationship management.

Based on the Theory of Planned Behavior (TPB), this research investigates the purchasing behavior model of online customers from the viewpoint of user behavior. Since loyalty is a crucial factor dominating consumers' real purchasing behaviors [37] and the main profit source of electronic retail websites is loyal customers [25, 40], the research mainly examines the online customers' loyal behaviors. In addition to verifying if TBP appropriate for the discussed online purchasing behavior, the research also proposes an alternative model in which Satisfaction of Online Customers is adopted as a mediated variable in order to analyze its effect on the base model and to compare the two competing models.

II. Literature Review

II.1 Internet Use

To the business owners, setting up their websites on the Internet can provide them with the advantages of lowering the expenses and expanding the managing scope to the global market. Through websites, they offer their products and services to online customers, meanwhile the customers can browse the merchandise and decide if they want purchase the products or request for services [19]. E-retailing can be viewed as an application of the electronic feature of the Internet to play as a medium for marketing route and dissemination, performing as an integrated EC model for product sales and service offers.

Angelide [5] argues that e-retailing is the business offering merchandise and service to online customers

through the interactive process between both sides of the commerce. O'Connor and O'Keefe [34] pointed out the importance of the interactive model in the marketing process, indicating that it not only provides the opportunity for customers and business owners to interact before the transaction, but most important is the follow-up interactions in the transaction process and after the transaction. Scansaroli [38] found that comparing to traditional shopping, consumers can save more time, effort and money and obtain merchandise of more diversity through using search engines and browsing major websites online.

Some researchers have investigated website uses, for example, Liang & Lai [27] derived the website design functions from customer-oriented viewpoint; Sterenson et al. [41] explored the browsing attitude of the website users; Eroglu et al. [16] studied the atmosphere and quality created by retail websites.

II. 2 Customer Loyalty

Loyalty is a crucial factor which dominates the customers' purchasing behavior and represents their behavior tendency toward the merchandise or service [39]. Griffin [18] suggests that loyalty includes the following behaviors or attitudes of customers: frequently repeated purchasing, willing to use all kinds of products or serial services the company provides, praising the company and advertising it, and refusing the promotion activities of other companies. Lee, Kim and Moon [25] proposed that the value and profit of websites comes from the number of loyal customers. Srinivasan et al. [40] pointed out two main factors for evaluating online loyalty: customers' passing on and price tolerance. When the online loyalty increases, the price tolerance is higher, and the customers are more willing to recommend the company to others.

II. 3 Customer Satisfaction

Satisfaction is the customers' overall evaluation towards the merchandise or service before and after their actual purchasing behavior occurs. The evaluation content is mainly a comprehensive examination of the product/service quality, the acquired value, the performance and expenses. Howard & Sheth [20] defined satisfaction as the customers' assessment and cognitive status by comparing the expenses they paid and the rewards they obtained. Kotler [23] defined satisfaction as a kind of after-purchasing evaluation of the product quality based on what they expected before purchasing the product. Oliver [35] claimed that satisfaction is the mental expectation customers have of the products before the purchasing behavior occurs. If the product quality is not as good as the customers expected, this discrepancy will cause a sense of uncertainty, which affect the satisfaction degree of customers.

III. Theory of Planned Behavior

TPB is an expansion modified theory proposed by Ajzen [2]

based on Fishbein and Ajzen's [17] Theory of Reasoned Action (TRA), which has better explanation capacity on the actual behavior.

TRA predicts and explains the relationship between an individual's attitude and behavior based on the hypothesis that a behavior occurs due to the volitional control of each individual. According to TRA, one's will decides his actual behavior, and actual behavior is represented by behavior intention, which is affected by attitude toward behavior and subjective norm. Yet each individual's will control is affected by several internal and external factors, most behaviors have the uncertainty of certain degree. Thus, when investigating non-will factors affecting behaviors (such as opportunity, environmental resources, cooperation from others, and so on), the explanation capacity of TRA will decrease, and cannot offer reasonable explanations [3].

Ajzen [2] therefore expanded TRA to TPB, which has one more construct added - perceived behavioral control, control ability toward the opportunity and resource when a person adopts his behavior. This construct can enforce the prediction ability of behavior, while the other three constructs are affected by the external variables. The overall structure of TPB can be depicted in figure 1.

Behavior Intention is the intentional degree of certain behavior a person acts, which can reflect his own will. Through understanding the intention of a person's behavior, the possibility of this behavior being actually performed can be observed. Because the behavior intention and the actual behavior have an extremely close relationship, the intentional degree will determine the possibility of such behavior. Thus, by measuring such a latent component like behavior intention, the reason of adopting the real behavior can be derived. It is hypothesized in TPB that the attitude toward behavior, subjective norm, and perceived behavioral control are independent to each other, and can affect the actual behavior directly through behavior intention.

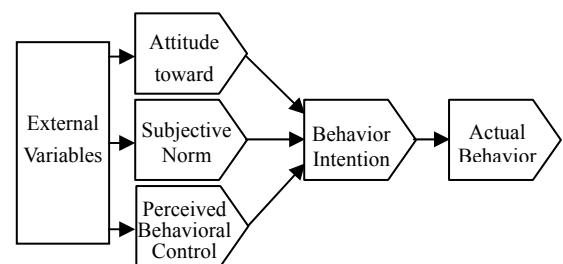


FIG 1. Overall Structure of TPB [2]

Attitude toward Behavior is the goodness or badness a person feels about a behavior or the positive or negative judgment after performing such behavior. The attitude is not the behavior itself, but both have high consistency with each other. If a person can act following his own free will, his attitude shall be highly consistent with his behavior [29].

Subjective Norm stands for the impact and stress from the social groups around a person when he decides to act

certain behavior. The stress from these surrounding social groups (such as parents and friends) is mainly caused by the thought that this person considers them as his important others and cares about their agreement of his behavior. Ajzen and Fishbein [1] thought that if the influence of the attitude toward behavior is larger than the social stress, the attitude will decide the intention of behavior, and vice versa.

Perceived Behavioral Control is defined as simplicity degree that a person tries to perform certain behavior. The control may be dominated by the past training, experience and the current obstacles. If a person has more chances, resources and performing capabilities, and believes there are fewer obstacles, then the degree of Perceived Behavioral Control is higher, and the control cognition is stronger. Hence, the influence of this perceived behavioral control tends to be more obvious.

TPB is based on the hypothesis that the behavior intention will become more obvious when the attitude toward the behavior tends to be more positive, the stress from the surrounding social groups is stronger, and the degree of the presumed control abilities is larger. Mathieson [32] adopted TPB to explain the behaviors of students using the trial balance and found out that the three major components of this theory (the Attitude toward Behavior, the Subjective Norm and the Perceived Behavioral Control) could explain the Behavior Intention properly. Talor & Todd [42] used TPB to study the cognitive and psychological factors which affect the use of information, and they proposed a behavior model for the use of Information Technology to analyze the service behavior of the computer center in business school. The result indicated that TPB could effectively explain the use of information.

IV. Research Model

TPB is adopted in this research to explain the loyalty of online customers. The research model includes five constructs: LOYalty of online customers (LOY), behavior INTention (INT) of online customers, ATTitude toward behavior (ATT) of online customers, SUBjective norm (SUB) of online customers and PERceived behavioral control (PER) of online customers; the definitions of constructs is listed in Table 1.

IV.1 Loyalty of Online Customers

According to Griffin's definition of loyalty [18], this research proposes the following four dimensions of LOY: "Continued Sales" is when customers having the same purchasing demand, they are willing to come back to use the same online transaction service; "Extended Consumption" is when customers having the other purchasing demand, the request from customers for further related online transaction services; "Resistance against a competitor's discount offers" can be viewed as when other retailing channels offer promotion discounts or decent services, customers will not take the offers and stay with online transaction services they originally used; and "recommendation of the product or

service to others" is the enthusiastic recommendation way of customer behaving about the use of online transaction services.

IV.2 Behavior Intention of Online Customers

INT is defined as the intentional degree of certain behavior a person acts for purchasing online, which can reflect his own will. In the operational level, this research proposes the intentional degree of collecting and requesting product or service information through the Internet can reflect customers' will for further purchasing merchandise or service online. The operational items for INT include searching for products information [12, 43] and new products information [40] through the Internet, using the information or searching services provided by retailing websites [12, 28, 30, 43], and responses from retailing websites to the requests of customer problems [28, 42].

TABLE 1. Construct Definitions

Construct	Definition
LOY	The loyal degree of online customers when a customer purchases merchandise or service on the Internet, including the following four dimensions: continued sales, extended consumption, resistance against a competitor's discount offers, and recommendation of the product or service to others.
INT	The intentional degree of certain behavior a person acts for purchasing online, which can reflect his own will.
ATT	The goodness or badness a person feels about the behavior of online purchasing or the positive or negative judgment after performing such behavior.
SUB	The impact and stress from the social groups around a person when he comes to a decision to perform online purchasing behavior.
PER	Simplicity degree that a person tries to perform online purchasing behavior.

IV.3 Attitude toward Behavior of Online Customers

The research defines ATT as the goodness or badness a person feels about the behavior of online purchasing or the positive or negative judgment after performing such behavior. In the operational level, this research refers to the related literatures for most feelings the online customers experience and develops the following items: ease of use [28, 29, 31], personal customization [15, 31, 44], convenience [12], autonomy [12], interference [12], privacy [31, 38], and security [12, 17, 44].

IV.4 Subjective Norm of Online Customers

The research defines SUB as the impact and stress from the social groups around a person when he comes to a decision to perform online purchasing behavior. In the operational level, this research refers to related literatures [28, 32] and develops the following items of SUB: some information to promote the convenience of online purchasing through newspapers and media; the advertisement and the marketplaces business owners provide on the Internet; and the purchasing experiences, recommendations and consulting of the relatives and friends.

IV. 5 Perceived Behavioral Control of Online Customers

The research defines PER as the simplicity degree that a person tries to perform online purchasing behavior. Past training, experiences and current obstacles may influence PER. In the operational level, this research refers to related literatures [14, 30, 44] and develops the following items of PER: the accumulating experience of using the Internet by time and frequency; the familiar degree of using the Internet; the ability to gather enough product and service information, to make purchasing decisions, and to judge the safety of websites.

The overall research framework is shown in Figure 2. The research hypotheses are as follows:

- H1: Behavior intention has positive effect on loyalty of online customers.
- H2: Attitude toward behavior has positive effect on behavior intention of online customers.
- H3: Subjective norm has positive effect on behavior intention of online customers.
- H4: Perceived behavioral control has positive effect on behavior intention of online customers.

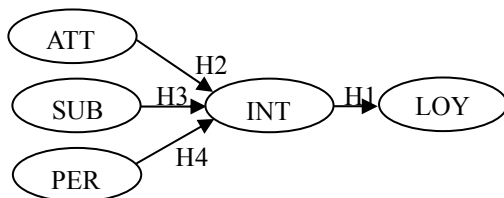


FIG 2. Overall Research Framework

V. Research Model

V. 1 The Research Process

The survey method is used to collect the empirical data. A questionnaire is developed and a five-point scale is applied to the measurement of total 45 questionnaire items. In order to effectively represent the constructs in the research model, this study adopts certain procedures to ensure that the measurement can achieve the expected quality. In respect of the content validity, this study refers to the viewpoints of the TPB theory and relevant EC papers to develop questionnaire items. In respect of the face validity, this study invited ten users with Internet shopping experiences to discuss the questionnaire wording in order to ensure that the person can

understand all the questionnaire items. Furthermore, thirty-five graduate students in the areas of business and information management participated in the pre-test. Thirty-five valid samples are obtained and analyzed by the tool SPSS 10.0 for Windows. The initial reliability analysis and exploratory factor analysis are conducted to check the reliability of questionnaire items and the appropriateness of their factor structure.

The Structural Equation Modeling (SEM) method is adopted and the software LISREL 8.71 is used to conduct the SEM analysis. This study first evaluates measurement models by the Confirmatory Factor Analysis (CFA) method. The structure model is then examined to test the hypothetical relationships. This study also proposes an alternative model with the construct Satisfaction of Online Customers as a mediator. Multiple goodness-of-fit indexes are compared between the two competing models.

V. 2 The Data Collection

In addition to one hundred and fifty samples distributed via the Internet, three hundred questionnaires are distributed to college students (including undergraduate and graduate), staffs and faculties with Internet shopping experiences from a university in northern Taiwan. Out of the total 450 questionnaires distributed, 423 valid samples are collected after deducting the samples with more than three items not answered. The effective response rate is 94%. The correlation matrix for all constructs is shown in Table 2, in which SAT (SATisfaction of online customers) is a mediated variable proposed in the alternative model. The descriptive statistics of respondents' characteristics are shown in Table .The operational definition of SAT and the details of the alternative model are further described in section 5.4.

TABLE 2. Correlation Matrix

	LOY	INT	ATT	SUB	PER	SAT
LOY	1.00					
INT	0.60	1.00				
ATT	0.41	0.68	1.00			
SUB	0.40	0.66	0.65	1.00		
PER	0.40	0.67	0.73	0.51	1.00	
SAT	0.63	0.73	0.50	0.48	0.49	1.00

V. 3 The Data Analysis

The measurement model

Through the CFA method, this study basically examines the following two subjects: (1) whether the factor loading estimates are significant, that is, the t-values should be greater than 1.96 at the significant level of 0.05; (2) whether the measurement models are good of fit. The overall fit of the model to the data can be evaluated by goodness-of-fit measures. The goodness of fit of the whole model may be judged by means of the following measures:

- Chi-square (χ^2)
- Comparative Fit index (CFI) [9]
- Normed Fit Index (NFI) and Non-Normed FI (NNFI) [7]
- Root Mean Square Error of Approximation (RMSEA) [10]
- Standardized Root Mean square Residual (SRMR)

According to Joreskog and Sorbom [23], if the model is correct and the sample size is sufficiently large, the χ^2 test may be used for testing whether the model fits the data well. Instead, χ^2 may be regarded as a goodness-of-fit measure in the sense that the degrees of freedom (df) is provided to judge whether χ^2 is large or small. Large χ^2 values correspond to bad fit and small χ^2 values to good fit. The criteria of goodness-of-fit measures are as follows: χ^2/df is suggested to be smaller than 2 for good of fit [11] and 3 for acceptable fit [13]; CFI greater than 0.95 for good of fit [8]; NFI, NNFI greater than 0.9 for good of fit [21]; SRMR smaller than 0.08 for good of fit [21]; and RMSEA smaller than 0.05 for good of fit and 0.08 for acceptable fit [33].

This study deletes SAT4, SAT9, ATT8, SUB5, SUB7, and PER2 which are suggested by the standardized residuals output to have large negative/positive residuals between variables. For model modification, LISREL8 provides modification indices (MI) which indicate an improvement in fit measured by a reduction in χ^2 . It is recommended only when relaxing a parameter makes sense from a substantive point of view [23]. This study follows the principle of unidimensionality in developing index and scale [6] and deletes PER3 which is suggested by MI to have multidimensional factor loadings.

The Maximum Likelihood (ML) results of loading estimates and goodness-of-fit measures are shown in Table 4 and Table 5. The values of the factor loading between all latent variables and their first observable variable are fixed to 1 for the purpose of standardization. All t-values for loading estimates are greater than 1.96. χ^2 of the two measurement models are 340.83 with 116 degrees of freedom ($\chi^2/df=2.9381$, $p<0.0000$) and 378.66 with 132 degrees of freedom ($\chi^2/df=2.8686$, $p<0.0000$) respectively. And other goodness-of-fit measures indicate that the measurement models are acceptable (CFI>0.95; NFI, NNFI >0.9; RMSEA<0.08; and SRMR<0.08).

The reliability

The reliability statistics are shown in Table 6. The values of Cronbach's α are all above the 0.7 level and thus satisfy the reliability requirement.

The structure model

As the statistics for the base model shown in Table 9, χ^2 of the structure model is 905.50 with 343 degrees of freedom ($\chi^2/df=2.6399$, $p<0.0000$). Other goodness-of-fit measures are as follows: CFI=0.96, NFI=0.94, NNFI=0.96, RMSEA=0.062, and SRMR=0.072. The statistics indicate that the structure model is acceptable.

The structure model with standardized solutions is shown in Figure 3. All path coefficients are significant indicating that the hypothesized relationships H1~H4 are supported. Square Multiple Correlations (SMC) for the structural equations are also reported. SMC for the structural equations indicate the explained proportion of variance in the endogenous variables accounted for by the variables in the structural equations [23]. The effect results of the path analysis are shown in Table 7. The test results of hypothesis are shown in Table 8.

V. 4 Alternative Model Comparison

Furthermore, this study proposes an alternative model with a mediated variable SATisfaction of online customers (SAT) added into the base model. SAT concerns a customer view of online transaction quality. A shared expression of satisfaction includes the consumer's perceived expectations [36]. SAT is therefore coupled with the consumer's prior intention about the online quality and very possible to influence the subsequent behavior.

TABLE 6. Coefficient of Reliability

Construct	α
LOY	0.8143
INT	0.7554
ATT	0.7653
SUB	0.7626
PER	0.7672
SAT	0.7251

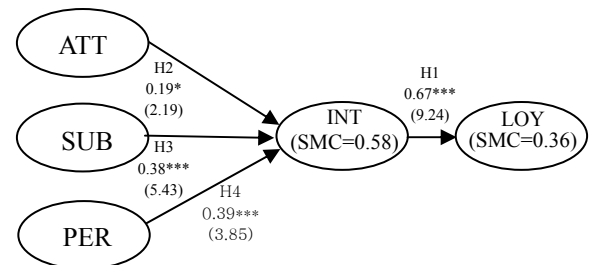


FIG 3. Structure Model with Parameter Estimation

TABLE 7. Effects of Path Analysis

Latent endogenous variable	Latent exogenous variable	Indirect	Direct	t-value	Total
INT	ATT	-	0.19	2.19*	0.19
	SUB	-	0.38	5.43***	0.38
	PER	-	0.39	3.85***	0.39
LOY	INT	-	0.67	9.24***	0.67
	ATT	0.13	-	2.16*	0.13
	SUB	0.26	-	4.93***	0.26
	PER	0.26	-	3.66***	0.26

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

TABLE 8. Test of Hypotheses

Hypothesis	t value	Decision
H1	9.24***	Accepted
H2	2.16*	Accepted
H3	4.93***	Accepted
H4	3.66***	Accepted

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

This study defines the concept of SAT as a perceived level of electronic transaction quality resulting when a customer purchases merchandise and receives services on the Internet. This study also proposes that SAT has components such as product satisfaction with price [12, 30, 43], time and energy consumed [12, 30, 43], and quality of product from Internet shopping [28]; and service satisfaction with service items [30, 31], order and transaction processing [12, 28, 30, 43, 44] and services after sales [24, 28, 35, 42].

As shown in Figure 4, SAT is proposed to influence LOY and to be influenced by INT. The two added research hypotheses are as follows:

H5: Behavior intention has positively effect on satisfaction of online customers.

H6: Satisfaction has positively effect on loyalty of online customers.

In Figure 4, all path coefficients are significant indicating that the hypothesized relationships H1~H6 are supported. The SMC of LOY is 0.44 for the alternative model greater than 0.36 for the base model. This indicates that the alternative model has higher explained proportion of variance in the endogenous variable “online customer loyalty”.

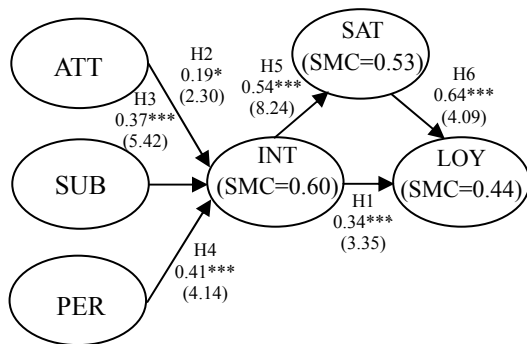


FIG 4. Alternative Model with Parameter Estimates

The results of model comparison are shown in Table 9. χ^2/df is 2.45168 for the alternative model smaller than 2.63994 for the base model. This indicates that the alternative model has a smaller χ^2 value corresponding to better fit after considering the degrees of freedom. And the comparison for other goodness-of-fit measures is as the follows:

- The CFI-values are the same.
- Although NFI is 0.93 for the alternative model smaller than 0.94 for the base model, the NNFI values are even indicating that the fits for the two

models are the same after considering the degrees of freedom.

- RMSEA is 0.059 for the alternative model slightly smaller than 0.062 for the base model. This indicates that the alternative model fit the data a little better.
- SRMR is 0.071 for the alternative model a little smaller than 0.072 for the base model. This indicates that the alternative model is with a slightly smaller error.
- ECVI [10], AIC and CAIC [4] are indexes indicating the level of model parsimony, especially useful for comparing competing models. The smaller the three indexes, the more parsimonious the model is. The ECVI, AIC, and CAIC values for the base model smaller than the ones for the alternative model. This indicates that the base model is more parsimonious.

TABLE 9. Model Comparison

Fit measure	Base model	Alternative model
χ^2	905.50	1350.88
df	343	551
χ^2/df	2.63994	2.45168
CFI	0.96	0.96
NFI	0.94	0.93
NNFI	0.96	0.96
RMSEA	0.062	0.059
SRMR	0.072	0.071
ECVI	2.44	3.58
AIC	1031.5	1508.88
CAIC	1349.49	1907.62

In summary, both the base model and the alternative model are acceptable when judged by the criteria of goodness-of-fit measures. The alternative model fits the data slightly better by having smaller χ^2/df , RMSEA, and SRMR. The alternative model also has higher explained proportion of variance in LOY than the base model. However, the base model is more parsimonious.

VI. Discussion and Conclusion

Internet, one of the fastest growing media, was developed for facilitating the supply of all kinds of products and service. It attracts millions of people to participate the online activities everyday through the friendly explorer interfaces. In addition to providing electronic information and integrated functions, the next stage of company websites is to provide electronic transaction service including online order and payment mechanisms [22]. It's essential for website owners to have knowledge of the behavior of online customers. How to attract more people to visit and shop on the website, and continue to become a loyal customer is extremely of importance.

The study develops a research model of loyalty for online customers based on TPB. Some results are found after

the SEM analysis:

- TPB can be used to explain the loyal behavior of online customers.
- Behavior intention directly influences the actual loyal behavior of online customers. This result indicates that if we want to keep an individual continuing to purchase online, it's practical to increase the intensity of his/her behavior intention.
- Attitude toward behavior is the largest effect factor for behavior intention of online customers. The second effect factor is subjective norm. And the last one is perceived behavioral control. The result indicates that the factors which influence the intention in sequence are: the positive feeling and evaluations the users have toward the online behavior, the reference opinions from surrounding people, and the final is the capability and resource of the users to use the Internet.
- In the alternative model, behavior intention indirectly influences loyalty of online customers through the mediated variable satisfaction. The SMC of loyalty for the alternative model is 44% exceed 36% for the base model. The result displays that the alternative model has a great explanatory power on loyalty of online customers.

The research limit of this research is that the data were not randomly selected. Most samples are collected from the college/graduate students. Although the online users are in reality younger and have higher academic background [26, 28], the results still cannot be generalized. In addition, the universities in Taiwan have provided overall environment for the Internet use and basic courses of computer information are opened in many departments. Hence, the samples collected in this research may cause a lower estimation of the influence of Perceived Behavioral Control of online customers.

The future research can expand to various influential models, and continue discussing these influential factors that involve in users' adoption of online behavior. In the SEM analysis, the comparison of competing models can help to measure and evaluate these influential factors and their effects. Besides, this research expects to examine competing models such as moderated models and multi-group models, in order to establish a better research model for explaining the online behaviors.

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TABLE 3. Descriptive Statistics of Respondents' Characteristics (N=423)

Characteristic	Range	Frequency	Percentage	Cumulative percentage
Gender	Male	190	44.9 %	44.9%
	Female	223	55.1 %	100 %
Age	≤ 20	91	21.5 %	21.5 %
	21~25	246	58.2 %	79.7 %
	26~30	48	11.3 %	91.0 %
	31~35	23	5.4 %	96.5 %
	36~40	8	1.9 %	98.3 %
	≥ 41	7	1.7 %	100 %
Career	Student	338	79.9%	79.9 %
	Military, public servant, teacher	32	7.6 %	87.5 %
	Health cares	26	6.1 %	93.6 %
	business and Manufacturing	12	2.8 %	96.4 %
	Financial and banking	3	0.7 %	97.1 %
	Info and mass communication	2	0.4 %	97.5 %
	Other	10	2.4%	100 %
Education	Senior high school	11	2.6 %	2.6 %
	Junior college	13	3.1 %	5.7 %
	College	310	73.3 %	79.0%
	Graduate school	89	21.0 %	100 %
Purchase frequency within one year	1-2	164	38.8 %	38.8 %
	3-4	110	26.0 %	64.8 %
	5-6	65	15.4 %	80.1 %
	7-8	19	4.5 %	84.6 %
	9-10	22	5.2 %	89.8 %
	≥ 11	43	10.2 %	100 %
Average of purchase expenditure	≤ NT 500	144	34.0 %	34.0 %
	NT 501~1000	155	36.6 %	70.7 %
	NT 1001~2500	73	17.3 %	87.9 %
	NT 2501~5000	35	8.3 %	96.2 %
	NT 5001~10000	10	2.4 %	98.6 %
	≥ NT 10000	6	1.4 %	100 %

TABLE 4. ML Estimates and Fit Indexes for Measurement Model of LOY, INT and SAT

TABLE 4. ME Estimates and Fit Indexes for Measurement Model of LOY, INT and SAT											
LOY	Var.	Std. solution	Completel y Std	Std. error	t- value	SAT	Var.	Std. solutio	Completel y Std	Std. error	t- value
	LOY1	0.69	0.68	-	-		SAT1	0.44	0.50	-	-
	LOY2	0.58	0.72	0.07	12.74		SAT2	0.46	0.53	0.14	7.55
	LOY3	0.66	0.78	0.07	13.55		SAT3	0.39	0.40	0.14	6.25
	LOY4	0.66	0.77	0.07	13.37		SAT5	0.47	0.49	0.15	7.20
	LOY5	0.55	0.53	0.08	9.62		SAT6	0.50	0.61	0.14	8.19
INT	Var.	Std. solution	Completel y Std	Std. error	t- value		SAT7	0.45	0.51	0.14	7.36
							SAT8	0.58	0.63	0.16	8.32
	INT1	0.63	0.77	-	-	$\chi^2=340.83$, $df=116$, $\chi^2/df=2.93818$, $p=0.00000$ CFI=0.96, NFI=0.93, NNFI=0.95 IFI=0.96 GFI=0.91, PGFI=0.69, RMSEA=0.068 RMR=0.044, SRMR=0.055					
	INT2	0.59	0.74	0.06	14.61						
	INT3	0.65	0.77	0.07	15.14						
	INT4	0.54	0.67	0.07	13.20						
	INT5	0.24	0.25	0.08	4.75						

TABLE 5. ML Estimates and Fit Indexes for Measurement Model of ATT, SUB and PER

TABLE 3. ME Estimates and Fit Indexes for Measurement Model of ATT, SUB and PER											
SUB	Var.	Std. solution	Completely Std solution	Std. error	t-value	ATT	Var.	Std. solution	Completely Std solution	Std. error	t-value
	SUB1	0.57	0.71	-	-		ATT1	0.65	0.40	-	-
	SUB2	0.69	0.88	0.07	16.24		ATT2	0.49	0.56	0.11	6.82
	SUB3	0.65	0.83	0.07	15.61		ATT3	0.56	0.65	0.12	7.23
	SUB4	0.59	0.68	0.08	13.01		ATT4	0.62	0.67	0.13	7.30
	SUB6	0.27	0.29	0.08	5.58		ATT5	0.63	0.68	0.13	7.33
	SUB8	0.28	0.27	0.09	5.24		ATT6	0.61	0.64	0.13	7.17
							ATT7	0.60	0.63	0.13	7.17
PER	Var.	Std. solution	Completely Std solution	Std. error	t-value	$\chi^2=378.66$, $df=132$, $\chi^2/df=2.86863$, $p=0.00000$ CFI=0.96, NFI=0.94, NNFI=0.96 IFI=0.96 GFI=0.91, PGFI=0.70, RMSEA=0.067 RMR=0.052, SRMR=0.059					
	PER1	0.49	0.53	-	-						
	PER4	0.60	0.66	0.13	9.31						
	PER5	0.64	0.73	0.13	9.80						
	PER6	0.69	0.77	0.14	10.04						
	PER7	0.52	0.52	0.13	8.04						

Business Value of E-Crm: A Multi-Case Study of Applications in Manufacturing and Service Industry of Taiwan

Chiung-Fen Huang, Lin Chao Jun

Institute of Information Management, Chiao Tung University
Management Building 2, 1001 Ta Hsueh Road, Hsinchu, Taiwan 300, ROC

TEL : (03)571-2121-57401 ,FAX : (03)361-7998

huangcf@ms60.url.com.tw ; hitti@so-net.net.tw

Abstract: Since it is a well known fact that the cost to attract a new customer is approximately 5~10 times more than the cost of keeping existing clients for the enterprise, it is a very crucial issue for the business to focus on the need of customer relationship management. Therefore, e-CRM (electronic CRM) is widely accepted recently and the adopting rate in certain organization is up to 49% annually.

In this study, a systematic multi-case study in Taiwan is performed for the B2B manufacturing industry and B2C service business in order to find the critical function and important issues for e-CRM in those businesses. In addition, the efficiency factors for e-CRM are analyzed since the roles of the clients in B2C and B2B are different, i.e., the organizational and personal behavior is compared.

The preliminary results show e-CRM in Taiwan has been successfully improving the service for B2B and B2C and promoting closer relationship for both the sellers and buyers. The target of new customer acquiring is also improved effectively.

Keywords: e-CRM, Multi-Case study, manufacturing, service business.

I. Introduction

Customer Relationship Management (CRM) has changed dramatically throughout its dynamic transformation from a conceptual framework to a core business function. CRM isn't just the domain of gurus or a software package anymore. To succeed in managing customers, managers must address e-CRM as part of their core operations. E-CRM is not just customer service, self-service web applications, sales force automation tools or the analysis of customers' purchasing behaviors on the internet. E-CRM is all of these initiatives working together to enable an organization to more effectively respond to its customers' needs and to market to them on a one-to-one basis.

II. Literature Review

CRM has long been hailed as a way for companies to find, influence, and retain customers. CRM solutions have evolved to go beyond simple contact and sales management

application to now link sales, marketing and customer support operations into a single, cohesive platform. E-CRM concept provides the ability to capture, integrate, and distribute data gained at the organization's Web site throughout the enterprise.

A company's continued success comes from two groups: new customers and repeat customers. Since it always costs more to attract new customers than to retain current customers, customer retention is more critical than customer attraction. The key to customer retention is customer satisfaction [1].

E-CRM expands the traditional CRM techniques by integrating technologies of new electronic channels, such as Web, wireless, and voice technologies, and combines them with e-business applications into the overall enterprise CRM strategy [2]. In other words, what the traditional CRM delivers can be considered only a fraction of an e-CRM solution.

E-CRM applications have the power to create an enormous amount of value by allowing companies to collect, organize, and disseminate a wealth of customer information. The e-CRM concept is designed to understand who the customers are and the products that are of interest to them—only then is it possible to provide them with the products and services they want. A more sound approach is to install a comprehensive software platform of the following five applications that together enable the e-CRM business process.

Essentially, this model shows how a firm can develop and manage customer relationships to enhance competitiveness and create a strategic advantage. It is also a powerful tool for building stronger and more loyal customer relationships [3].

III. The Outcomes of Implementation

Enterprises should change their managerial approaches and business process. They can not only simplify the transaction and customer service process, but also provide customers with more considerate customized services which can make differences from others, enhance customer loyalty, decrease the steps of sales, and reduce the sale cost. The well outcomes after introducing e-CRM of the four selected case companies are arranged as follows:

Advantech <http://www.advantech.com/>

Advantech is an enterprise which has the most successful

e-business website for his automated products in the world. 80% of incomes until 2001 are from his electronic business operation. The beneficial results after implementing e-CRM are as follows:

1. Raise customer loyalty and profits
2. Reduce the cycle time of new products and serve the target customers in the most economical way.
3. Steeply decrease the transaction cost, service cost and service time.
4. Own a stable e-Business platform
5. Customer classification and the detailed information of the top 15 customers will be independently further analyzed
6. Automated pricing process and the order can be integrated with ERP system
7. Enhance the productivity of service engineering department
8. Organizational learning
9. Reduce 22% of sales and marketing cost

Arima <http://www.arima.com.tw/>

Arima used to be the government-chosen enterprise for setting a model of applied development planning, the planning period was from July 1 of 2002 to the end of 2003, the implementation performance are as follows:

1. Raise the service quality and satisfaction of customers
2. Always know the repair condition and remain the repair records
3. The transparency of inventory volumes is helpful to reduce global inventory and make it more elastic in control. The delivery speed and quality are also quite raised.
4. Improve and simplify the inside operation process of enterprises. Consolidate the accounting management and auditing.
5. Quick information acquirement can help managers have the ability of quick response, information transparency, and know the latest situation in real time.
6. Participate the supply chain of electronic business hosted by Arima to make suppliers, transporters commonly take part in this supply chain and their relationship tighter with global market.
7. Follow the standard of Rosettanet, and make suppliers and transporters do not need to introduce other operation systems due to different operation and information standards.
8. Provide Arima with the information from HUB, to make both of them have more time and information to prepare materials.
9. Base on the document of forwarder RN 3B3/3B18 and the real-time information exchange of merchandise delivery tracing, the related operation staffs in Arima can easily understand the shipment status.
10. Arima provides different solution policies in the aspect of B2B, and reduces the introduction cost of related projects through the standardization of specification.

Fareastone <http://www.fetnet.net/>

The benefits that e-CRM brought in the case companies, Fareastone, are illustrated as follows:

1. Decrease the cost of business operation
2. Implement the marketing affairs and raise service quality
3. Raise the satisfaction of customers
4. Adjust the structure of staffs
5. Trend and fashion, and the image improvement of enterprise

DaimlerChrysler Taiwan <http://www.mercedes-benz.com.tw/>

DaimlerChrysler Taiwan used to be suffered from low efficiency of car repair, bad management of part inventory, and unclear information of customers. However, the customers of DaimlerChrysler Taiwan currently are able to acquire information they need in three minutes through e-CRM. It totally improves the dilemma which always takes 3-5 days for data mining and other analysis by IT staffs. The system DaimlerChrysler Taiwan set up basically owns four critical dimensions of performance:

1. Become a kind of assistant tool for marketing
2. Understand consumers and self product.
3. Performance analysis of repair factory
4. Part inventory control

IV. Synthesized Benefits and Analysis

The conceptual structure of e-CRM is at least composed of the following five concepts: application of information integration, application of customer analysis, application of sales promotion management, application of real-time decision making, and application of individualized messages etc. The e-CRM system of the research case in the paper is just constructed from the above five concepts, and then do customization for each enterprise base on their requirements.

According to the above four cases, the five success factors and four advantages of e-CRM can be arranged:

Some CRM research firms report that nearly 70 percent of CRM implementations fail to deliver measurable benefits. In contrast, IBM research has found that companies that focus on and prioritize critical activities actually increase the likelihood of CRM success by more than 70 percent—flipping the ratios.

The five success factors or keys to doing e-CRM right are:

- Realize your e-CRM value case for change.
- Identify and prioritize your e-CRM value propositions.
- Design your new e-CRM operational blueprint.
- Construct your transformational multi-generational roadmap and implement your solutions.
- Build support for your e-CRM efforts and stay on track through sponsorship, governance, and change management.

And the four advantages of e-CRM are shown as follows:

Efficiency

Efficiency comes from the correct and rapid operation process without any waste. For example: The traditional manual process is replaced with automation, and the accomplishment of information rationalization. In the above ways, enterprises can increase their margin of profit and reduce cost.

Benefit

Benefit comes from the better or the more simple operation process. For example: the more income growth brought by new software application, mixed sales, telephone service center, interactive sales tool, customer collaboration, product tuning tools, and other sales methods without any participation of salesmen, are all the empirical benefit-oriented application

Cost saving

DaimlerChrysler Taiwan made use of e-CRM to effectively lower the inventory; Advantech also used it to reduce 22% of sales and marketing cost, Arima made his product deployment and the check-up of electronic orders in streamline shape. Undoubtedly, e-CRM does not only makes the sales process smooth and improved, but also shorten the delivery cycle time from the initial ordering to the final shipment.

Invisible benefit

The individual behaviors and organizational behaviors about the introduction of e-CRM are quite different. In the organizational behavior aspect of B2B, the relationship between the upstream and the downstream industries becomes more solidified due to owning the same information communication platform of e-CRM system. Besides order taking, the communication interaction among systems and the information transparency go one step further. Invisibly the industries built a higher entering barrier from other industries. For instance, Arima applied the standard of Rosettanet to make its suppliers and transporters not necessary to introduce other operation systems. Moreover, organizations emphasize the coordination and the convenience of system use between the upstream and the downstream industries. In the individual behavior aspect of B2C, customers tend to pay more attention to their feeling. The pleasure shopping atmosphere can be helpful to customer return. Mehrabian indicated that three key emotional variables that may determine behavior are pleasure, dominance, and arousal [4]. However, in other researches, It is also illustrated that while convenience and control are at the top of consumers' lists of benefits from online shopping [5][6], enjoyment of the shopping experience may also be an important determinant of customer loyalty [7].

It is easily understood that four case companies used different kinds of methods to do their e-CRM, like the sales promotion messaging of cell phone in Fareastone,

DaimlerChrysler Taiwan made the utilization of information integration of front-end (client) to manager the inventory, Advantech used e-CRM to enormously extend his customer service time and take advantage of its application on information integration to allow the customers to inquire their RMA returned purchases from internet, which reduce lots of complaints of customers and delay of returned purchases.

In other words, the case companies transformed their conventional static and single-way customer services of CRM limited in the factors of time and space, to the real-time and two-way customer services of e-CRM without any limitation of time or space. They also hope to introduce more functions in e-CRM system so as to enhance their competency. In the future, the height of business intelligence decides the success or failure in markets. If enterprises can make use of e-CRM to make a recheck up for its business process, it is believed that enterprises are able to increase the benefit of its investment and create more competitive edges.

V. Conclusions and Future Works

E-CRM is the edge tool that can help enterprise to raise its competitive advantage in electronic business. To make conclusions for the research, the business added value of the investment in e-CRM can be found as follows:

- (1) Raise the satisfaction of customers
- (2) Reduce cost
- (3) The information transparency can improve the managerial ability of inventory control
- (4) Improve the relationship between collaboration partners and customers
- (5) Heighten the entering barrier
- (6) Improve the image of enterprise

Taiwanese manufacturing industries and service industries currently obtain lots of benefit and advantage after introducing e-CRM, especially in the aspects of raising the satisfaction of customers and increase the proportion of market holding. In the future, if some advanced technologies such as MVPN and Push mail receiving, can enhance the mobility of staffs to achieve the goal of enterprise mobilization easier; the use of RFID can trace the staffs, movement of merchandises, the volume of inventory, and position vehicles, to further improve managerial performance or the Location Based Service. It helps enterprises to know all kinds of information well in this moving process so that the business efficiency can be increased..., all the above can be more beneficial to the introduction performance of e-CRM. Moreover, the selection of the industries in the paper is limited in the Taiwanese manufacturing and service industries, In the future, more different kinds of industries in Taiwan or the same kinds of industries in other foreign countries can be other research issues, and then it is believed that more enlightenment from those related researches can be found.

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SWIS: Web-based Intelligent System of Intellectual Capital for SME in Thailand

Anongnart Srivihok^a, Dencho Batanov^b, Wongkot Pojpongsan^a,
Hathaichanok Kornchee^a, Sasithorn Mongkolsripattana^a, Orawan Watchanupaporn^a

^a{Department of Computer Science, Faculty of Science, Kasetsart University, Bangkok, Thailand} email: anongnart.s@ku.ac.th

^bSchool of Advanced Technologies, Asian Institute of Technology, Thailand
email: batanov@cs.ait.ac.th

Abstract: In the knowledge economy, Intellectual Capital (IC) has been reported as the new measure for enterprise values, intangible assets and economic performances. Customer Relationship Management (CRM) has also been recognized as a new paradigm of business services. However, the knowledge about IC and customer services in Thailand is very limited according to the very few studies reported up to now. In order to overcome these difficulties, the Web based Intelligent System for SME has been developed to provide knowledge and serve as an intelligent system for measuring the Intellectual Capital and CRM for SMEs in Thailand. The performance of this Web-based system has been evaluated by 10 Thai SMEs. Results revealed that participants in the evaluation are satisfied with the system and they are willing to use it in the near future.

Keywords: Web Intelligence, Web Based Information Technology, Intelligent Systems, Intellectual Capital, CRM, SME.

I. Introduction

Intellectual Capital (IC) plays an important role for the innovation and competitive advantage in the new era of knowledge society. IC is a driver or catalyst of organisational growth. This catalyst is a significant resource for any company as it has a major and considerable impact on its performance. Due to the limited number of research on IC in Southeast Asia, the understanding of IC measurement and management is a substantial problem for many enterprises in this region. Our preliminary analysis of CRM readiness in SME [9] shows that this is also true for most of Thai SME.

In order to compete successfully in the highly competitive local and global market, CRM is a significant factor for all companies including small, medium and large enterprises. It is commonly accepted that companies spend five times more money to acquire a new customer than to keep an old one for purchasing a new product [8]. CRM is a proven approach for increasing the competitiveness. It is a business strategy providing complete combination of business functions for contacting the customers such as marketing, sales, customer service and field support via assembling of people, process, and technology. CRM is based on coordination of all business processes that deal

with customers. Further, it involves the collection, collation, and interpretation of customer data to attract and keep customers through business process in order to create long-lasting, customer centric and mutually beneficial relationships [5], [7].

To provide more knowledge and understanding of IC, its management, and measuring the effect of CRM, a systematic study on the necessity of building information system for Thai SME has been conducted by a joint team from Kasetsart University and Asian Institute of Technology in Bangkok. The basic result of that study was the created framework for development and deployment of a prototype of SME Web-based Intelligent System (SWIS).

This paper is divided into four sections. Section two describes the most recent studies on IC and the proposed IC measurement model. Section three justifies the methodology used for developing the system. Section four summarizes the results from the prototype system evaluation. The last section includes some discussions and draws the conclusions.

II. Literature Review

In Bontis (1999) four performance measurement systems including human resource accounting (HRA), economic value added (EVA), Balanced Score Card (BSC), and Intellectual Capital (IC) are proposed. The HRA aims to quantify the economic value of people to the organizations and also provide input to managerial and financial decisions. There are three types of HRA models: cost models, HR value models and monetary emphasis models. HRA models estimate human capital in financial terms and are applied in organizations where human capital plays important role in organizational value. However, all models are subjective and suffer of lack of reliability. EVA is an overall performance measurement which bundles capital budgeting, financial planning, goal setting, performance measuring, shareholder communication and incentive compensation. This model emphasizes on measuring financial indicators while none of intangible resources are evaluated. Balanced Score Card (BSC) is a multi-dimensional measurement system proposed by Kaplan and Norton (1996). This system assesses both financial and non-financial factors including customer perspectives, internal process, and these factors are linked in a logical system. BSC is different from traditional measurement systems since it adds non-financial factors. Therefore BSC neglects the hidden values of employees and pays attention to the importance of knowledge management as significant drive

of the economic success and sustainability of the organization [2].

Intellectual Capital (IC) is introduced in the beginning of 90s and became well known by Skandia - the largest insurance company in Sweden. Recently, a significant amount of studies have been oriented to and focused on intangibles, knowledge management, and IC measurement by both researchers and practitioners. There are some substantial IC measurement models proposed in those studies. The most famous IC definition has been suggested by Edvinsson (1997) which states that “The Intellectual Capital of a firm is its possession of the knowledge, applied experience, organizational technology, customer relationships and professional skill that provides it with a competitive edge in the market”. The Skandia Model extensively refers to IC measurement and includes both financial and non-financial factors just like BSC. In this model IC is comprised of human capital and structural capital. Human capital includes knowledge, know-how, skills and personnel expertise. Structural Capital is a composite element that includes organizational capital and customer capital. Organizational capital consists of innovation capital (intellectual property and intangible assets) and process capital (databases and information systems). Customer capital is the external capital which includes the organizational relationships with external actors including customers, suppliers, partners and/or other stakeholders. Skandia model measures the company intangible assets and extends the traditional financial model measuring the real value of the company. More specifically, Skandia model includes customer capital, which plays an important role in creating company’s value. Furthermore, this model consists of organizational and process factors, which have not been included in traditional models. However, this model lacks of some indicators for customer relationship management.

Engstrom et al. (2003) conducted a case study of the intellectual capital evaluation for a hotel chain in Scandinavia. The ICAP methodology and multiple source data were used to investigate the knowledge and data produced by an intellectual capital evaluation, and explored the potential relationship between intellectual capital and business performance. The ICAP methodology was analysed together with financial indicators including (a) ability to generate sales and control expenses; (b) revenue per available room; (c) occupancy percent; (d) room profit; (e) food sold profit; and (f) personnel cost. However this measurement model is specific for the hotel industry. More over, there are still unanswered questions about the proposed model including (1) reflection on the operationalized constructs; (2) the model represents the essential of intellectual capital; and (3) the truthfulness of the model.

Srivihok and Intrapairrote (2004) have proposed the IC measurement model specifically for SME which includes three clusters: human capital, structural capital and relational capital. This model is originated from Skandia model. Relational capital in this model consists of customer capital

and actors including partners, government actors and suppliers. Customer relationship indicators are added to make the model more practical for SME.

II. 2 The IC Measurement Model

The IC measurement model used in our development is derived from Srivihok and Intrapairrote (2004). The model includes three clusters: human capital, structural capital and relational capital. The new IC model is adjusted for the Thai SME and presented in Figure 1.

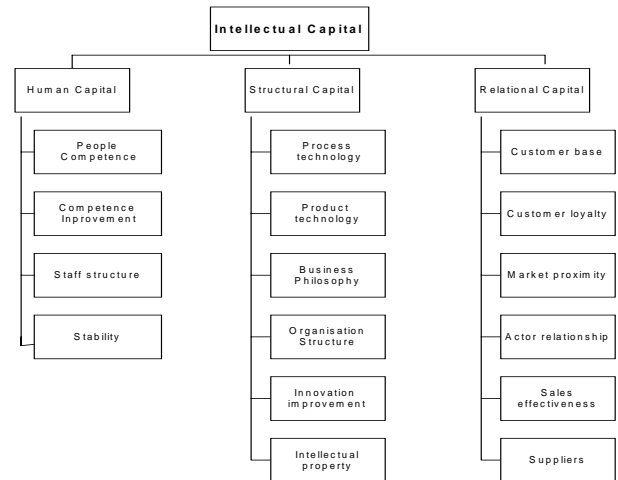


Figure 1. Intellectual Capital measurement model

Human capital refers to the employee knowledge of a firm and capacity to generate this knowledge. The value has been created by employees through using their skills, applying their knowledge and initiating innovative ideas. The utilization of employee knowledge and skills are performed if the employees are willing to do so. Thus, the human capital management should be concerned about knowledge management of employees including maintenance of knowledge base, encouragement, innovation and motivation of employees to transform their tacit knowledge to explicit knowledge [11]. There is also a direct cause effect relationship between knowledge *reuse* and *invention* of new knowledge. Then knowledge is turned into value by commercialization which is called *exploitation*. The summary of the above two factors (knowledge *reuse* and *invention*) multiply by exploitation is *innovation* [4]. In addition, human capital is the fundamental knowledge to generate the other two Intellectual Capital components. The human capital does not belong to a company but it is “hired” by the company for a period of time. This capital will be removed when staff resigns or is retired from the company. Human capital includes people competence, competence improvement, staff structure, and stability (as shown in Table 1 in Appendix 1).

Structural capital is a composite item which is mainly organizational capital. It comprises information and communication systems, management systems, patents and everything that systemizes knowledge of the company and makes it internal and explicit. This capital consists of seven

main indicators: business philosophy, organization structure, intellectual property, research and development (R&D), process technology, product technology and IT penetration per total investment [e.g. key word and directory search engine, EDI (Electronic Data Interchange), and database]. The structural capital belongs to and still remains within an organization even though employees have resigned. Structural capital includes process technology/ IT penetration, product technology, business philosophy, organization structure, improvement of innovation, and intellectual property (as shown in Table 2 in Appendix 1).

Relational capital refers to external relations with customers, suppliers, partners, networks, and regulators. Customer relationship is the value resided in the marketing networks and relationships that a company develops by doing their business. The quality of the relationships, the ability to keep present customers and creating new customers are key factors for the success of a company. The relational capital is classified into customer base, customer loyalty, market proximity, actor relationship, sales effectiveness, and supplier base (as shown in Table 3 in Appendix 1).

III. Conceptual Design of SME Web-based Intelligent System (SWIS)

SWIS is designed for Thai SMEs and consists of four main modules: (1) Navigation, (2) Library, (3) Intelligent System, and (4) Support System. In Navigation, new user starts with registering its personal information to the system, logging in to and out from the system. Library module consists of the following sub-modules: Intellectual Capital, Knowledge Management, Customer Relationship Management, SME and generals. Both Thai and English-translated documents in the library are selected from text books, academic magazines, journals and knowledge portals. The Intelligent System module includes Intellectual Capital and CRM questionnaires for SME to evaluate. Then, the systems will give advice related to the data which have been put in and may suggest documents to be read respectively. The Support System module provides information for SMEs about using facilities in the system such as web board, Help and FAQ and also more specific information such as SME Laws and Regulations, Strategic Planning, Management and Software. The design of SWIS is depicted in Figure 2.

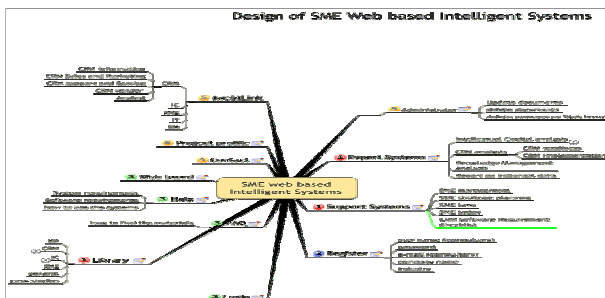


Figure 2. Design of SME Web-based Intelligent System (SWIS).

III. 1 Architecture of SWIS

The system consists of user interface, access control, analyzer agent, and knowledge base (Figure 3). Users get access to the system via the web based interface. The analyzer agent is responsible for analysing and extracting the users' information for each category such as Intellectual Capital or CRM by using provided input data, and it is referenced with the provided knowledge base. Advice messages, documents, activities and support actions are prepared. Authoring interface is updated by administrator. Knowledge base includes documents for SME, guides for SMEs in doing business, rules, Intellectual Capital management and information technology management in organisations, principles and procedures in CRM. The advised message and answers are sent back to users by passing access control and user interface.

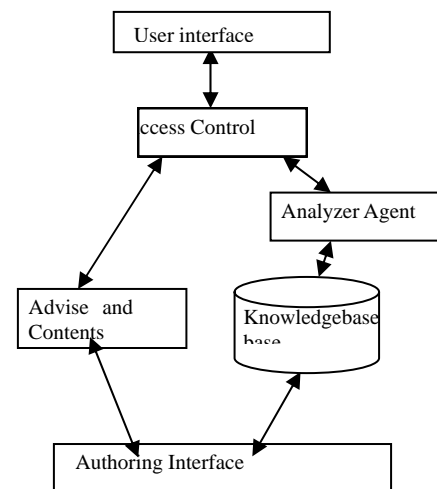


Figure 3. SWIS architecture

III. 2 Prototyping of SWIS

The front page of the system is depicted in Figure 4. In the system, SME can evaluate the company Intellectual Capital (IC) by putting company information in the model (as shown in Figure 5). The system analyses and compares data with benchmark values for IC. The items are reported if their values are higher, or lower than benchmarks. If they are lower, the system suggests related IC materials for SME to be read. These materials can be retrieved from SWIS. Results from IC model measurement are depicted in Figure 6.

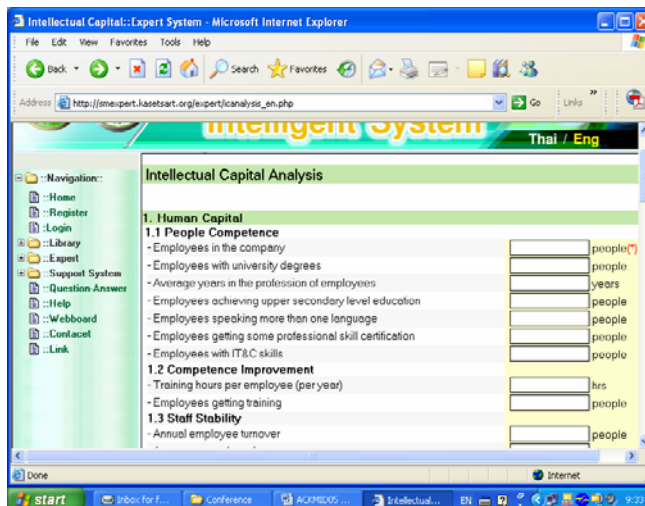
Figure 4. SWIS home page (<http://smexpert.kasetsart.org/>)

Figure 5. Intellectual Capital Analysis model

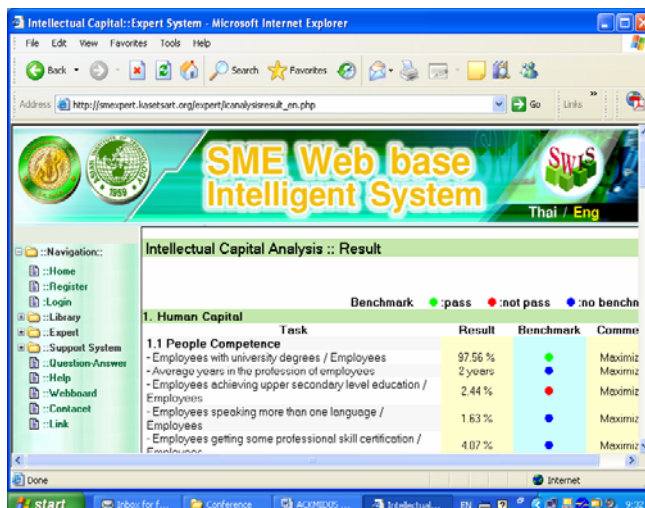


Figure 6. Results of Intellectual Capital Measurement.

III. 4 CRM Evaluation

SMEs can evaluate their organisation readiness for CRM implementation by using CRM readiness module (Figure 7). Then the system will give advice or suggest activities to be performed according to organisational characteristics (Figure 8).

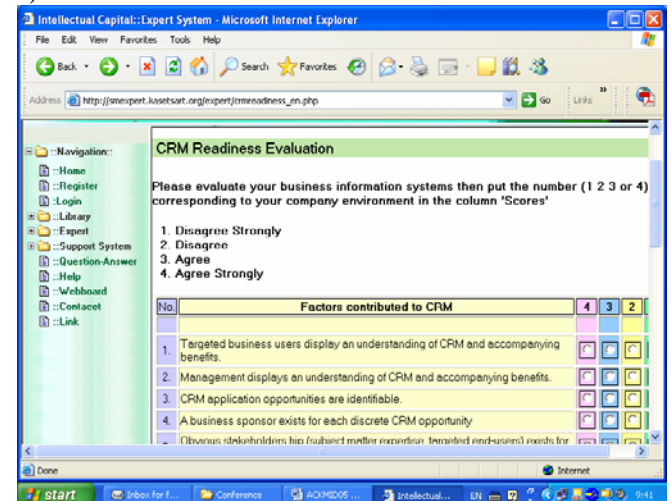


Figure 7. CRM readiness module for SME evaluation.

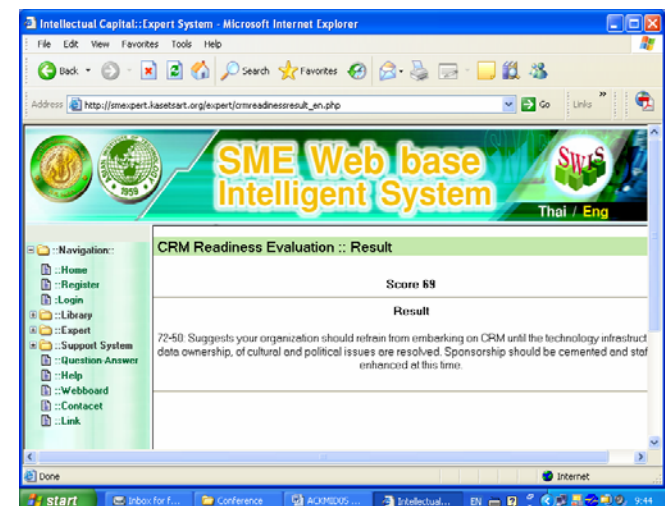


Figure 8. Results from CRM readiness evaluation.

IV. System Evaluation

The system evaluation was designed to be an exploratory, cross sectional, statistical, and based on survey. For the purpose of evaluation we investigated ten Thai SMEs from various industry types. Participants were provided with survey questionnaires. Each questionnaire is divided in two parts: Section 1 is on organisational characteristic (presented in Appendix 2) and Section 2 is system performance evaluation.

IV. 1 Organisational Characteristics

Participants from ten Thai SMEs have been selected to evaluate the systems. Their profiles are illustrated in Table 1.

Three SMEs are in IT services, two are software houses, and the rest are in printing, media production, education, construction and import. Majority of them have 10-100 employees. The registered capitals are between 5 and 300 million Baht. Most companies are relatively young with 5-10 years of services. There are two companies approved for applying ISO9000 for quality assurance. Majority of the respondents are managers who do the administrative work in the organisations.

IV. 2 System Performance Evaluation

The model has been evaluated using the evaluation questionnaires (Appendix 2). Participants evaluate the four main criteria: system performance, user interface, design and presentation, and perceive usefulness. The evaluation score ranges from 1 to 5 on Likert scale. If participants are very satisfied with the model, they will give the score of 5. On the other hand, they will give the score of 1 if it requires some improvements. The feedback information from the ten cases is illustrated in Table 2.

The evaluation scores range from 72% to 90.4%, which implies that the participants are satisfied with this system. All participants accept the system and are willing to access the system in the future. However, some revealed that the model should be simplified to match better with SMEs in various fields.

V. Conclusions

Competing in the knowledgebase society requires that organizations get the maximum benefits from their human capital (employees), structural capital (organizational structure and information systems) and relational capital (relationship with customers and actors). It is difficult to manage these capitals since the measurement tools are not widely introduced and understood. The literature review shows that a very little work has been carried out on the study of IC measurements in Thailand. To overcome this deficiency, the paper introduced a measurement tool for evaluating intangible assets in the company. This measurement model includes three clusters: human capital, structural capital and relational capital. The qualitative measuring indicators are developed to the respective content. SME Web-based Intelligent System (SWIS) has been developed and described in this paper. It provides various measurement modules including IC, CRM implementation

and KM implementation. It also includes knowledge base of IC, CRM, KM and SME management. The system itself contains valuable information that gives each organisation an opportunity to effectively work with and improve the intellectual capital and CRM. Working with this system is useful for strategic planning and for improving business performance.

Acknowledgement

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Table 1: Participant Profile

Characteristics		Case									
URL:		1	2	3	4	5	6	7	8	9	10
Types of business	Software house						✓				✓
	IT services		✓	✓		✓					
	Tourism										
	Manufacturing										
	Finance & Banking										
	Printing	✓									
	Media production								✓		
	Other please specify				Education			Construction		Import	
Number of staff	1<10			✓							
	10-50	✓	✓		✓						✓
	51-100					✓		✓			
	100-200						✓			✓	
	>200								✓		
Registered Capital (Million Baht)		10	10		5		150	300			
Years in service.....		20	10	2	5		13	15	10	5	
Awards received											
Your company have procedures for quality control such as....	TQM										
	CMM										
	ISO9000, ISO.....		✓				✓				
	Other..Please specify				5S				Q S H E		
Do you agree to reveal your company name for this project?	Yes										
	No	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Does your company is a subsidiary of an overseas company?	Yes				✓						
	No	✓	✓	✓		✓	✓	✓	✓	✓	✓
Does your company is a subsidiary of a Thai company?	Yes								✓	✓	
	No	✓	✓	✓	✓	✓	✓	✓			✓
Position		*	**	**	**	**	**	**	**	**	**

* assistant manager

** manager

***customer support

Table2: Score of prototype testing

List of Criteria		Evaluation Score (Level of satisfaction =1-5)									
Main Criteria	Sub Criteria	1	2	3	4	5	6	7	8	9	10
System performance	Results are accurate	5	5	5	4	4	4	4	4	4	4
	Results are complete	5	4	5	5	4	4	4	3	3	4
	Convenience of use	4	5	4	5	4	5	5	4	3	4
	Rapid processing time	5	5	5	5	4	5	5	4	3	4
User interface	Content matches your requirements	3	4	4	4	3	4	3	4	3	3
	Understandability	4	4	4	4	4	4	3	4	4	4
	Required time for processing is compatible with participant attention	5	4	5	4	4	4	3	4	4	4
	Ease of use, simplicity	4	4	4	4	4	5	4	4	3	4
	Appropriate alternative command	3	4	4	4	-	3	4	3	3	4
	Clarity of error message	4	4	4	5	4	3	4	3	4	4
	Fault tolerance	4	4	4	4	4	3	3	3	2	4
	Re-accessibility	5	5	5	5	3	5	5	3	3	3
Design and presentation	Suitable font type	5	5	4	5	4	4	4	5	5	4
	Text is printed in suitable size	5	5	4	5	4	4	4	5	5	4
	Suitable font color	5	4	4	5	4	4	4	5	5	4
	Clear and appropriate graphic design	4	3	4	4	4	4	4	5	4	4
	Simple and attractive web pages	3	4	4	4	3	4	4	4	4	3
	Appropriate web links	3	4	4	5	4	4	4	5	4	4
	Contact address/ person is available	1	1	4	4	4	3	2	5	5	4
	Understandable user guide is included	1	1	4	5	3	3	2	5	3	3
	Online help is comprehensive and readily available	1	1	4	4	4	3	2	5	3	3
Perceived usefulness	Useful content for work	4	3	5	5	4	4	3	4	4	4
	Results can be used to improve your organization	4	3	5	5	3	4	3	4	3	4
	Comparability of present to prior results	NA	4	5	4	3	4	3	4	3	3
	Willing to access the system next time	3	4	5	5	4	4	5	4	3	4
Total scores (125)		90	94	109	113	90	98	91	103	90	94
%		75	75	87	90	72	78	73	82	72	75

Appendix 1

Table1. Human Capital indicators

Characteristics	Indicators
People Competence	Number of employees
	% employees with university degrees
	Average years in professional
Competence improvement	Training expenses
	% internal training
Staff structure	Number of new employees
	Supportive staff/ line staff
	Average age of employees
	Ratio of Male/female
	% part time employees/total employees
Stability	% employees leave company
	Employees feel they are professionally recognised
	Number of full time employees

Table 2. Structural Capital indicators

Characteristics	Indicators
Process technology/IT penetration	Number of Personal Computer/employee
	% employees with internet access
	Number of standard certifications
Product technology	Number of services
Business philosophy	Investment for planning
	No. of channel for transferring business philosophy
Organisation structure	Number of hierarchies level
Improvement of innovation	Number of innovation projects
	Number of new products or services
Intellectual property	Number of patents
	Number of brands or trademarks
	Research and Development expenses

Table 3. Relational Capital indicators

Characteristics	Indicators
Customer base	Number of customers
	Investment in customer information
	% customers pay on time
	% customers perform 60% of sales
	% sales performed by new customers
Customer loyalty	% customer lost
	Average year customer remaining in company
Market proximity	Number of participation in exhibitions
	Number of channels customers access to company
	% marketing investment/ revenue
	Invest in marketing information
Actor relationship	Number of strategic alliances
	Investment for partner information
Sales-effectiveness	Sales growth
	Investment for sales system
Supplier base	Number of suppliers
	Number of lost suppliers / total number of suppliers

Appendix 2

Evaluation Questionnaire FOR IC Model

Section 1: Organization Profile

1. Website of your company (URL:)
2. Types of business

<input type="checkbox"/> Software house	<input type="checkbox"/> IT services
<input type="checkbox"/> Tourism	<input type="checkbox"/> Manufacturing
<input type="checkbox"/> Finance & Banking	<input type="checkbox"/> Printing
<input type="checkbox"/> Media production	<input type="checkbox"/> Other please specify_____.
3. Number of staff

<input type="checkbox"/> <10	<input type="checkbox"/> 10-50	<input type="checkbox"/> 51-100	<input type="checkbox"/> 100-200	<input type="checkbox"/> >200
------------------------------	--------------------------------	---------------------------------	----------------------------------	-------------------------------
4. Registered Capital.....Baht
5. Years in service.....
6. Awards received.....
7. Procedures for quality control of the company.....

<input type="checkbox"/> TQM	<input type="checkbox"/> CMM	<input type="checkbox"/> ISO9000 ,ISO.....
------------------------------	------------------------------	--------------------------------------------

 Other please specify.....
8. Are you willing to reveal your company name for this project?

<input type="checkbox"/> Yes	<input type="checkbox"/> No
------------------------------	-----------------------------
9. Does your company is a subsidiary of an overseas company?

<input type="checkbox"/> Yes	<input type="checkbox"/> No
------------------------------	-----------------------------
10. Does your company is a subsidiary of a Thai company?

<input type="checkbox"/> Yes	<input type="checkbox"/> No
------------------------------	-----------------------------
11. Your position

<input type="checkbox"/> MD	<input type="checkbox"/> Manager.....
-----------------------------	---------------------------------------

Section 2:

Please evaluate the system performance in order to bring your feedbacks to improve the model.

List of Criteria		Evaluation Scores (Level of satisfaction):				
		Very good	Good	Fair	Poor	Must Improve
		5	4	3	2	1
System performance	Results are accurate					
	Results are complete					
	Convenience of use					
	Rapid processing time					
User interface	Content matches your requirements					
	Understandability					
	Required time for processing is compatible with participant attention					
	Ease of use, simplicity					
	Appropriate alternative command					
	Clarity of error message					
	Fault tolerance					
	Re-accessibility					
Design and presentation	Suitable font type					
	Text is printed in suitable size					
	Suitable font color					
	Clear and appropriate graphic design					
	Simple and attractive web pages					
	Appropriate web links					
	Contact address/ person is available					
	Understandable user guide is included					
Perceived usefulness	Online help is comprehensive and readily available					
	Useful content for work					
	Results can be used to improve your organization					
	Comparability of present to prior results					
	Willing to access the system next time					

Application of Business Intelligence Techniques in China Telecom

Li Haigang

School Of Management, Shanghai Jiao Tong University, P.R. China, 200052
hglihg@yahoo.com.cn

Abstract: In this paper, we have developed a data warehouse and an OLAP(on-line analytical processing) based framework that has been used for customer profiling and comparison. The system architecture for OLAP and data warehouse based calling behavior profiling and multilevel multidimensional pattern analysis is introduced. First, the method how customer profiles can be represented as data cubes is described, then, the architecture of a profiling engine is presented, finally, the process of using the engine to compute profiles and calling patterns is discussed and an application case of China telecom is studied.

I. Introduction

In the last decade, China's telecom industry has made great progress. The reopening of market and the lifted ban of government monopoly changed its whole situation and brought it development and innovation of great significance. Nowadays its scope of business has become increasingly extensive, and more and more services are becoming available. On the other hand, the development of basic institution doesn't match the increasing demand. And the expense on 3G has been heavy burden to the telecom industry. Then they turn to some basic aspects, such as lowering the operation cost and maintaining the service of their current customers.

Though to support the commercial operations, telecom companies have spent plenty of money and energy installing automatic systems, the real problems are always more complicated than the systems. For instance, they do know who their customers are and who may be interested in their new service. But in fact, they are not able to tell which customer are those who can bring them more profit, or which kind of service is more profitable, or which province should be paid more attention.

With the deepening of informization in China, especially the popularization of the data analytical software, the data accumulation of the users has come to a certain scale. But most of the users just do some simply or partial enquiry dealing with the data. In some sense, data may be burden rather than resource to them. For the business intelligence applications can do the analysis and mining of large volumes of transaction data to support business managers in making informed decisions, the situation can be improved.

II. Relative Concepts

As a technology of transforming the information of a company to useful resource as well as knowledge, business intelligence gathers, manages and analyzes large amounts of data on a company's customers, products, services, operations, suppliers, and partners and all the transactions between them. Business intelligence applications require the analysis and mining of large volumes of transaction data to support business managers in making informed decisions. Typically, these applications involve extracting data from operational databases, transforming the data, and loading it into data warehouses. The data in the warehouse is then input to a variety of reporting, querying, on-line analytical processing (OLAP) and data mining tools, which generate patterns, rule, or models used by business managers for making decisions. These decisions are then fed back in the form of business actions such as product recommendations or fraud alerts (see Fig. 1).

The overall architecture of an OLAP system comprises a hierarchy of basically three data models: the physical model, the logical model and the presentation model. The central logical cube model defines the concept of a cube and its corresponding operations. The physical model deals with how the cubes are stored or indexed for efficient access. The presentation model is concerned with grouping several logical cubes, defined as parts of one (or more) underlying cube(s), in one presentation entity. The mapping between these levels ensures independence and this is achieved through the use of the intermediate logical model.

III. Application of Crm Based on Olap in Telecom

III.1 Overview

In a telecommunication network, hundreds of millions of call detail records are generated daily. Business intelligence applications such as fraud detection and churn analysis require the collection and mining of these records on a continuous basis. An important component of many of these applications is customer profiling, which aims to extract patterns of behavior from a collection of transaction records, and the comparison of such patterns. In telecommunication applications, for instance, a customer's calling behavior is represented by the composition and periodic appearance of the callees (the persons called); time-windows (when calls are made); and duration (how long calls last). Trough e-commerce applications, a customer's shopping behavior could be represented by ads viewed, products selected, products bought, time-windows, price, etc. The techniques for customer profiling and comparison are very similar. Nowadays, Business Intelligence has attracted more and

more people's attention. In Europe and US, it even has been an essential equipment of the personal computer. And BI is believed to play a more and more important roll in our life in the future.

Since the similarity of customer behavior can be represented from different angles, they compare calling patterns derived from customer calling behavior profiles, rather than comparing profiles directly. For example, some calling patterns might be similar in terms of the volume (total number or duration) of calls to a set of callees, others

might be similar in terms of the time windows when these calls were made. Their objective, therefore, is to enable the comparison of calling patterns along multiple dimensions and at multiple levels of the dimension hierarchies. This type of multidimensional, multi-level pattern extraction and comparison is facilitated through the use of OLAP. Like many existing efforts, they take advantage of OLAP technology for analyzing data maintained in data-warehouses. In particular, they perform large-scale data mining on an OLAP based computation platform.

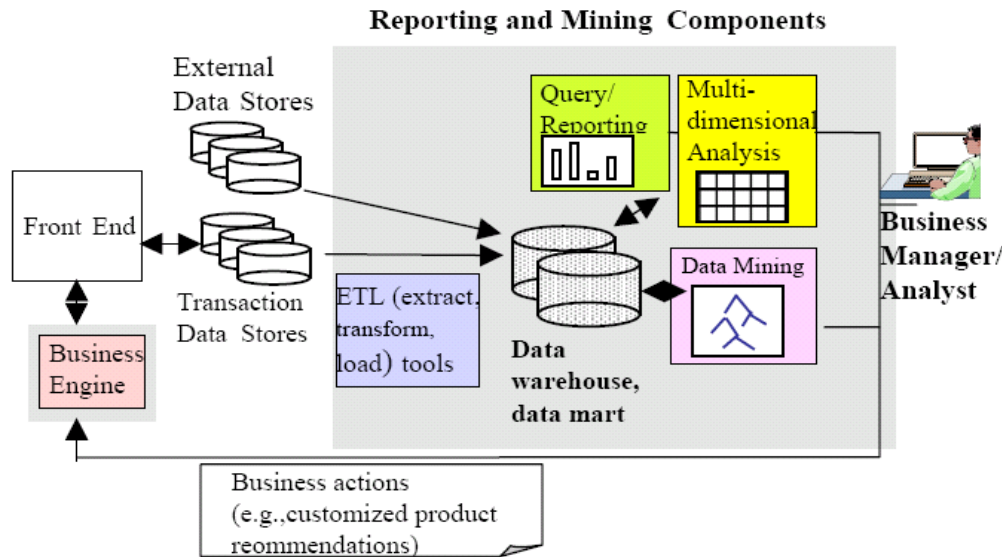


Fig. 1: A typical architecture for business intelligence

III. 2 The Construction of the MASA System

Application of information technology today in the telecom industry can be concluded like this: first, the prevalent instrument and software used nowadays cannot meet with the increasingly highly required service quality, and then, 0.2 billion telecom customers in China promise a profitable market, third, along with China's entering in the WTO, the telecom industry in China will confront strong competitors from all over the world. A chance but a challenge for state-owned telecom companies arises. In general, the telecom industry will burgeon in the near future and this could bring both opportunities and challenges.

ABC Mobile Communications (AMCC) has fully adopted the advanced business intelligence solutions provided by Informix, which aid it constructed the mobile communication market and consumer conduct analysis system (MASA). The development and application of MASA finds its origin from the urgent needs required by company's operation, which contains data mining (DM) analysis on historic data, kinds of report forms showing the status quo, dependable information when making a decision, and the support to operation system and net maintenance, etc. According to the demand of the enterprise, the data

warehouse in AMCC is the data-analyzing warehouse based on calling records. It contains list of VIP, assaying customers' credits (namely the Fraud Inspection), the calling stream, analyzing efficiency of the selling channels, assessing the effect of market competition and measures used in operation, etc.

In the process of operating the system, we construct the data warehouse that is independent from the payment recording system. The memory cells of data warehouse use the dynamic server options for advanced decision support system, the extraction and load of data adopt the loading system that is especially devised for applications of the data warehouse, data analytical and information visiting part use OLAP which is based on web techniques as well as multiple stratum client/server structure, meanwhile it can be shown directly through the combination with map information system. The system structure can be seen like fig. 2. First, AMCC does market segmentation by synthesizing and analyzing the different business behavior of consumers, and make relative product and consumption section to conduct cross-sale. Second, it Segments consumer and adjusts consumer structure and make marketing strategy by synthesizing and analyzing the accumulative total consume and payment behavior of consumers. Third, it can know information of sales channel and control the sales channel. Finally, the company uses the system to adjust the net

according to net operation analysis result. Fig. 3 shows the business development analysis result of AMCC.



Fig. 3 the business development analysis



Fig.4 analysis of customer cluster

Fig.4 shows the analysis result of customer cluster.

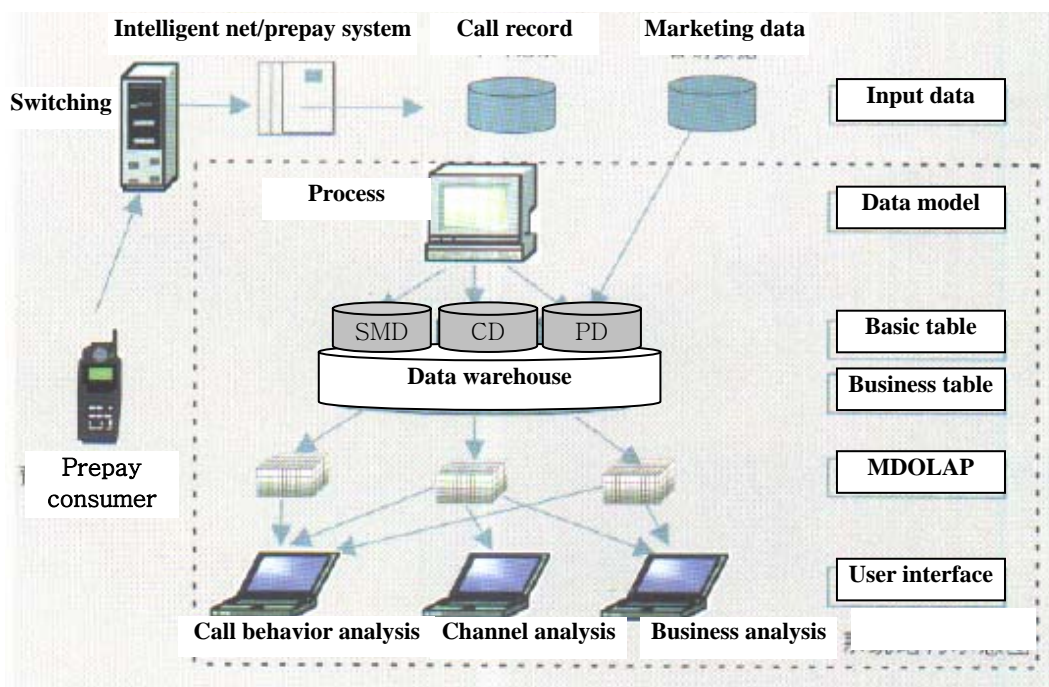


Fig. 2 MASA structure of BI system for prepaid
SMD: small message data, CD: calling data, PD: payment data

III. 3 Profiling Engine

To create and update customer behavior profiles, hundreds of millions of call records must be processed every day. The profiling engine is built on top of an Oracle-8 based data-warehouse and Oracle Express, an OLAP server. Customer behavior profiles and other reference data are persistently stored in the warehouse and handled in the OLAP multidimensional database (MDB) as data cubes. The profiling engine architecture and flow of data is shown in Figure 6. From the calling profile cubes, individual customer

based, multilevel and multidimensional calling patterns are derived. The similarity of calling patterns belonging to different customers, or belonging to the same customer but for different profiling periods, can then be computed. The profiling engine can be used by a fraud detection application to generate alarms when suspicious events are detected (e.g., a call exceeds some threshold, an abnormal calling pattern occurs; or a pattern similar to a known fraudulent one occurs). An investigator can then examine the case database to determine whether a fraud indeed occurred.

III. 4 Calling Pattern Cubes

A calling pattern cube is associated with a single customer for representing the individual calling behavior of that customer. Multiple calling pattern cubes may be generated to represent a customer's calling behavior from different aspects. They may be based on volumes or probability distributions; and they may be materialized (defined as variables) or not (defined as formulas). In our design, probability-based calling pattern cubes are derived from volume-based ones.

A volume based calling pattern summarizes a customer's calling behavior by counting the number of calls of different duration in different time-bins. Represented as cubes, they are commonly dimensioned by time, duration and dow (day of week), and in addition, for those related to outgoing calls, dimensioned by callee, and for those related to incoming calls, dimensioned by caller. Their cell values (measures) represent the number of calls. For example, a calling pattern might express that there were 300 short calls, 100 medium calls, and 50 long calls in the mornings of the profiling period, from one specific phone number to another. A probability distribution based calling pattern represents a customer's calling behavior with probability distributions. For example, a calling pattern from one phone number to another might express that 70% of the calls in the morning were short, 20% were medium, 10% was long. Cubes representing different probability measures can be derived from a profile cube or a volume-based pattern cube. For efficiency as well as consistency, it is only necessary to store profile cubes persistently in the data warehouse. Calling patterns, either based on volume or probability, can be

derived on the fly (at analysis time) using the OLAP engine for computation. This shows the simplicity, and yet the power, of OLAP for customer profiling.

IV. Conclusion

Telecommunication prepay satisfies the benefits of operation company and user. For operation company, prepay can avoids much debt from consumer, as for consumer, prepay is the best choice for those low consumption and low credit. In our approach, the OLAP engine actually serves as a scalable computation engine. From a performance point of view, it supports indexed caching, reduces database access dramatically and extends main memory based reasoning. From a functionality point of view, it allows us to deliver powerful solutions for profiling, pattern generation, analysis and comparison, in a simple and flexible way. We have developed the multi-dimension and multilevel cube similarity comparison formalism for comparing customers calling patterns in terms of cube manipulation.

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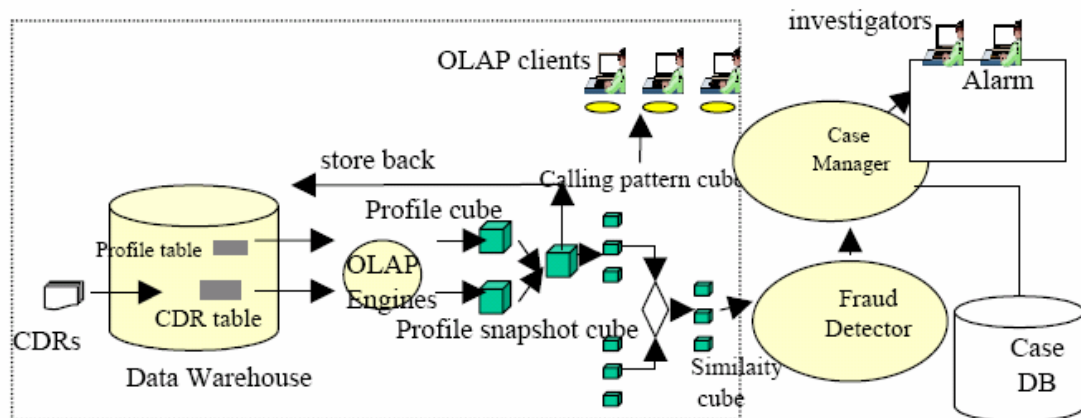


Fig. 6 Data-warehouse/OLAP based profiling engineering for fraud detection

An Initial Design of a Website Snapshot Management System

David Chao
College of Business
San Francisco State University
San Francisco, CA 94132
E-mail: dchao@sfsu.edu

Abstract: A website snapshot is the state of a web site at a specific point in time. It supports applications that require historical data. Most website snapshots are created by making a copy of the website. These date-time stamped physical snapshots are unable to satisfy users' need for snapshots of different snapshot times. This research proposes a scheme that is able to create website snapshots that meet any snapshot time requirements by recording changes to a website in a log. For web pages producing dynamic content from a database, this scheme will allow the pages to access a database snapshot at the website snapshot time.

I. Introduction

A website snapshot is the state of a web site at a specific point in time. It supports applications that require historical data and preserves website content for future reference. In practice, some website snapshots are created to answer questions about website content at the snapshot time for audit and compliance purposes [5]. Some are created due to government policies for preserving government-supported Web content [3]. Some are created in an attempt to preserve the web content as an archive of civilization for future generations to study. Creating and preserving web site snapshots have been ongoing undertakings of many web projects. An example is the Internet Archive which uses web crawler to collect all open access web pages since 1966. Its Wayback Machine lets users view snapshots of Web sites as they appeared at various points in the past [2]. Some are created for research and analyses that use snapshots to study certain trends in the study subject. Website snapshots enable researchers to analyze data with new tools that haven't existed before [2].

In addition to providing historical data, website snapshots are also used in web server's cache engines. The goal is to save bandwidth and improve download time by delivering data from the cache that otherwise would make repeated trips across the Internet. Similarly, popular internet search engines such as Google also create a cache of website snapshots in order to speed up searching [11]. Website snapshots can also be used as a backup of the operating website.

Website snapshots may exist in many forms. They may be accessible online as a server-side resource, downloaded to a user's machine, or created on a disk for offline access. A

typical way of creating a server-side website snapshot is using a program that copies files from the Web server to a computer at an archive. The snapshot may contain all the files at the site or a subset. Snapshots are taken periodically, so that the archive has a sequence of snapshots for each site [9]. A client-side website snapshot can be created by using a website downloading software; an example is Web Site Downloader [11]. This type of software lets users download an entire website, or a selective part of it, for offline viewing.

Although the process of creating a website snapshot is simple, it may still face some practical problems [1]. The state of a website changes whenever a change occurs to the website. Most website snapshots created today exist physically as a date-time stamped copy of the website. A major problem with the physical snapshot is that it only represents the website's state at one specific time. It is unable to satisfy a user's request for a snapshot of a different time. Dynamic web pages pose another problem because they use server-side and/or client-side script code to create dynamic content. These pages may also retrieve information stored in databases. Thus, retrieving the page alone may not yield the desirable result.

This research proposes an initial design for a website snapshot management system. The system is able to: (1) generate a website snapshot with any snapshot time specified by a user, (2) generate a website snapshot only when requested, and (3) provide database snapshot that is consistent with the website snapshot time to create dynamic content. The system is designed to manage the website snapshots of only one website.

II. Tracking Changes to Website State

II.1 The Needs for Tracking Changes

A web site is a system of integrated web documents where each document is identified by a URL. Therefore, the state of a website represents the state of all web documents of the website, and it changes whenever the website changes its content by inserting a new document, deleting an existing document, modifying a current document, relocating a document to a new directory, or reorganizing its directory structure.

A website as currently published is the result of past changes; it represents the current state of the website. Tracking all changes to a website to its current state enables a website to rollback its current state to any state in the past. In so doing, many non-current documents need to be kept; these include deleted documents and old versions of a

modified document. All old versions of a web document are its snapshots at various times in the past. The URL of a current document may also go through many changes due to a renaming or relocating of the document.

Figure 1 summarizes the effects of web site reorganization and change to a document on its URL. When a web site reorganizes its directory structure, all affected documents will have a new URL. Similarly, when a web document is renamed or relocated to another directory, it will have a new URL as well. When a document is modified, its URL will not change and the old version before the modification becomes the document's snapshot between the previous and the current modification. In order to retrieve the snapshot the old version is archived. A deleted document is archived as well for later retrieval.

Web site actions	Effects on current and historical links
Adding a new document	Adds a new URL to current links
Modifying a document	No change to URL; the old document becomes a snapshot and is archived
Deleting a document	Deletes a current link; adds a historical link and document is archived
Renaming a document	Adds a new URL to current links; the old URL becomes historical link
Relocating a document	Adds a new URL to current links; the old URL becomes historical link
Reorganization	Adds all affected documents' URLs to current links; all affected documents' old URLs become historical

Figure 1: Effects of web site reorganization and web document changes.

Together, the URLs invalidated by a web site due to reorganization, document removal, renaming, or relocation, plus the links to document snapshots are a web site's *historical links*. From this perspective, a website consists of two parts: links to current documents and links to historical documents..

II. 2 Factors Affecting Website State

A website state captures not only the code that defines the web documents but also the presentation of the web documents as a results of running the code [2]. Thus, factors affecting the rendering of web documents will affect website state. These factors include:

a. Web document code: This includes the code that creates web page's static and dynamic contents including server-side and/or client-side scripts. Frequently, code creating dynamic content is stored separately in a different file as in the case of Server-Side-Include, Code-Behind

technologies, and XML document style sheet.

b. The state of internal resources it references: Internal resources are files managed by a web site and are available in creating the web site's contents. Typical examples of internal resources referenced by a web document that affect its rendering are style sheets, files embedded by a Server-Site include directive, image files, script files, and databases. These internal resources may create dynamic contents that change every time the document is opened, and they are subject to change that consequently changes the web document's rendering. Many of these files are *internal supporting files* that are created for supporting a web document and are not for publishing individually.

c. The state of external resources it references: External resources are files not managed by the web site but can be referenced in creating the web site's contents. A web document may reference external style sheets, components, web services, or databases. These external resources are also subject to change.

d. Web site host environment variables: Script code may reference a host's system variables in creating dynamic content. A typical example is using the system clock to get the current date and time. A web document that displays the current date and time is always in a new state.

e. Web technologies implemented on the server-side as well as on the client-side: A web page is often created by using many technologies and may reference documents that are created by a different set of technologies. The complete rendering of a web document requires that all technologies, client-side and server-side, are properly implemented.

The first three factors affect the consistency of the data of a web document and are called *consistency* factors. The last two factors are *environment* factors. Figure 2 shows the relation between a web document and factors affecting its rendition. Note that a web page may be a composite document of several tightly-coupled documents, such as style sheets and code-behind files.

Based on the consistency factors' effects, three levels of a web document's snapshot can be defined. (1) Level 1 snapshot: A web document snapshot is the state of web document code at snapshot time. Creating a level 1 snapshot enables a web site to trace the changes to the web document code over time. (2) Level 2 snapshot: A level 2 snapshot is a level 1 snapshot with the additional requirement that all the internal resources it references are at least level 1 snapshot at the same snapshot time. These internal resources can be categorized into two groups: database and non-database files. For a database file to be a level 1 snapshot, it must be consistent with the state of the database at the snapshot time. (3) Level 3 snapshot: A level 3 snapshot is a level 2 snapshot with the additional requirement that all the external resources it references are at least level 2 snapshots at the snapshot time.

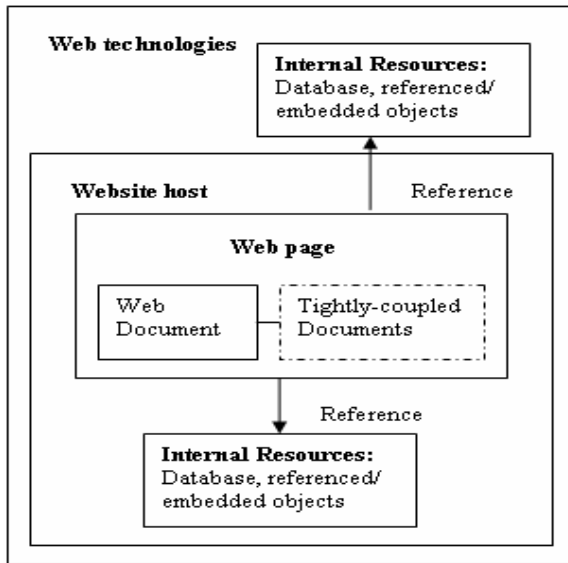


Figure 2: Relations between a web page and factors affecting its rendition.

The two environment factors will improve the consistency of a web document snapshot if they are enforced; that is, the host variables are reset to snapshot time and web technologies implemented are compatible with the technologies at the snapshot time. Four levels of consistency improvement are defined depending on whether the environment factors are enforced: (1) Plus 0: If both environment factors are not enforced. (2) Plus 1: If the host variables are reset to the snapshot time. (3) Plus 2: If web technologies are compatible with the technologies at the snapshot time. (4) Plus 4: If both factors are enforced.

Consistency factor				
Environment Factor		Level 1	Level 2	Level 3
	Plus 0	Level 1 + 0	Level 2 + 0	Level 3 + 0
	Plus 1	Level 1 + 1	Level 2 + 1	Level 3 + 1
	Plus 2	Level 1 + 2	Level 2 + 2	Level 3 + 2
	Plus 3	Level 1 + 3	Level 2 + 3	Level 3 + 3

Table 1: Levels of website snapshot

Table 1 summarizes all possible levels of snapshot states. The level 1 and level 2 snapshots are related to files that are managed by the website and changes to these files can be recorded by the website; hence, they are relatively easy to achieve. The level 3 snapshots involve resources that are not managed by the web site and it's difficult, if not impossible, for the web site to keep track of changes to these resources. This research develops a web document snapshot management system to deliver web documents' level 1 and level 2 snapshots.

III. Initial Design of Website Snapshot Management System

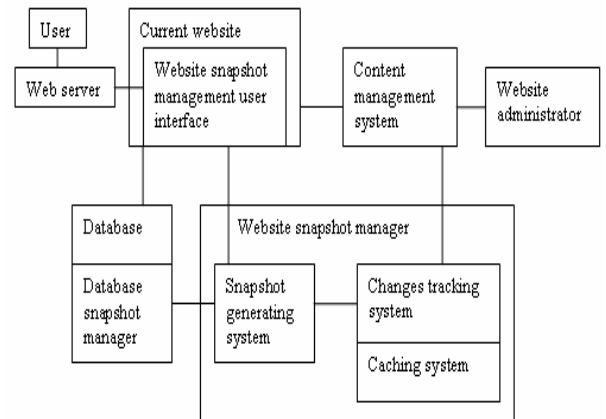


Figure 3: Components of a website snapshot management system.

This system consists of two modules: Database Snapshot Manager for maintaining database snapshots and Website Snapshot Manager for maintaining web document snapshots. Figure 3 shows the major components of this system in a typical website environment. This system assumes that the website administrator uses a content management system in maintaining the website. Changes to the website as discussed in the previous section are passed from the content management system to the Website Snapshot Manager.

The Website Snapshot Manager contains 3 components: (1) Changes Tracking System: This system uses a log to record all website changes including insertions, deletions, modifications of web documents, and changes to web document's URL. (2) Caching System: This system is responsible for storing deleted documents and old versions of current web documents. (3) Website Snapshot Generating System: This system generates a website snapshot based on a user's requirement for snapshot time.

The objective of the Database Snapshot Manager is to provide a database snapshot at any snapshot time requested by users. This requires recording all updates in a log. The log uses time stamp to record update times and uses flags to indicate deletions and insertions where a modification is treated as the deletion of the old version followed by an insertion of the new version. With such an update log available, rolling back the current database using updates with time stamp later than the snapshot time can generate a snapshot at any snapshot time. Database snapshot management and related materialized view management have been the topics of much research [3][4] [8] [9].

The current website contains a user-accessible module of snapshot management user interface. This interface lets users submit a request for a website snapshot. This request translates to a command: Create Website Snapshot As Of *snapshot time*.

IV. Summary

Website snapshots have been used in many applications. Most website snapshots are created by making a copy of the websites. These date-time stamped physical snapshots are unable to satisfy users' need for snapshots of different snapshot times. This research proposes a scheme that is able to create website snapshots that meet any snapshot time requirements by recording changes to a website in a log. For web pages producing dynamic content from database, this scheme will allow the pages to access database snapshots at the website snapshot time.

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Setting up Extended Enterprises: A Data Aspects Framework

Frank Goethals, Jacques Vandembulcke, Wilfried Lemahieu, Monique Snoeck

F.E.T.E.W. – K.U.Leuven – Naamsestraat 69, B-3000 Leuven, Belgium

{Frank.Goethals, Jacques.Vandembulcke, Wilfried.Lemahieu, Monique.Snoeck}@econ.kuleuven.ac.be

SAP-leerstool Extended Enterprise Infrastructures

Abstract: Nowadays, companies want to share information. When doing so, many issues have to be taken care of, and many options are available for most of these issues. Realizing B2Bi is a very complex task. It is the aim of this paper to make it possible to oversee the complexity of information sharing in a B2B context by structuring the issues that have to be taken care of in a new framework: the DA (Data Aspects) – framework; and by relating this framework to the existing FADEE framework.

Keywords: Data Warehousing and Data Mining

I. Intro: Structuring the Problem Space

Rather than *owning* information, *sharing* information is nowadays often said to be an important source of competitive advantages. Sharing data is, however, not an easy task. Many different issues have to be dealt with, and the many decisions that are taken should fit together, and should fit the requirements of the business.

This paper reports on our research-in-progress (updates will be posted at www.frankgoethals.tk – publications). The research is meant to overcome one of the frustrations one may get by reading through literature on B2B (Business-to-Business) data exchanges: such papers are typically very *fragmentary* without positioning the niche they cover within the entire field of data-exchange related issues. Moreover, while the discussions are often fragmentary, they are not ‘*normalized*’. With this we mean that concepts are used which seem to possess a number of properties in the mind of the authors, but which are not defined explicitly. These concepts can be looked at from different points of view, and by not presenting those viewpoints, or by highlighting only one, the concept remains obscure for the reader. For example, terms like an ‘extended enterprise wide datawarehouse’ are very obscure. Does this mean all the data is stored geographically in a location that is central and which can be accessed by all parties? Or does every party have a replication of all data? Or is the warehouse actually only a database with meta-data through which the scattered databases are connected? Can one request data from the datawarehouse, or should one subscribe at the warehouse to get the information the datawarehouse publishes? Is the ‘central database’ (whatever that means) located on the premises of one of the partners, or on a third party’s webfarm? Is one of the parties the ‘owner’ of the database,

or are all parties owner of a part of the database, or... Many questions and answers are thus hidden under such a title.

When looking at the data side of the B2Bi story alone, many issues can be identified that should be taken care of. In this paper we try to bring all these issues together in a simple framework.

In order to identify what are the data-related issues that should be dealt with in B2Bi in general, investigating a single in-depth case study was considered inappropriate. After all, choices and options become better visible if one case is contrasted with another one. Therefore, we decided to draw up the framework on the basis of a study of many cases that were published (also by others), as well as on papers that do not present specific cases but relevant constructs (e-business standards and the like). After some time of working bottom-up (i.e., starting from practices and trying to put them in a structure), we noticed the topics fitted in the often discussed classification of Zachman [17]. Zachman states that different (normalized) views are possible on some entity. Following Zachman, a discussion of an entity has to include the following six questions in order to be complete: what, how, where, who, when and why¹. Consequently, if one wants to find out how to deal with data, it is actually logical to stumble across these six questions. In what follows we handle the six questions as six boxes in which we can put data-related issues. As such, the six boxes function as a simple placeholder, a framework. We call this the DA (Data Aspects) – framework.



Figure 1: The DA (Data Aspects) framework

Knowing the six questions, we were able not only to work bottom-up, but also top-down. That is, while topics identified in literature nicely fitted with the six questions, the six questions helped us identifying issues that were not visible in literature. We could formulate questions such as ‘who wants the data?’, ‘where is the data?’, ‘how will the data be moved from point A to point B?’, etc.²

By working in both directions we believe we have covered a good part of the ground. Above that, the

¹ While in his ISA framework the entity under consideration is typically an entire enterprise, we consider ‘data’ to be the entity.

² We note that one may also apply the six questions to the meta-level. For example, in stead of discussing ‘who needs what data’ and ‘how he will get the data’, one may investigate ‘who should define who needs what data’ and ‘how he should define that’. For now, however, we do not look at this meta-level.

framework is well-structured so that at any moment new topics (if any would have been overlooked) could be added without repercussions for the existing framework (i.e., the six boxes will stand the test of time).

In the following section we present the data-related issues in the framework. While space limitations make it impossible to deal with the issues in detail, we discuss some options that are available in each box. After that, we bring a short case study from the health care industry, covering a number of different aspects.

The DA-framework enables people to easily pinpoint the data-related topics that have to be (or are being) dealt with in B2Bi. While the framework is a nice contribution because of this enablement, it does not show how to actually *deal* with the issues. Classifying the issues might create the impression that setting up B2B data exchanges is simple. Indeed, the classification gives people a clear view of what B2Bi entails. Still, dealing with the issues (and their interdependencies) is a complex task in which many people are involved. This is shown in the final section of the paper where we relate the issues in the boxes to the FADEE-framework (the Framework for the Architectural Development of the Extended Enterprise, see e.g. [8]).

II. The Design Variables to Play With

In what follows, we discuss the different issues that should be dealt with. The issues are grouped in six subsections showing the HOW, WHERE, WHO, WHAT, WHEN and WHY aspects respectively of the data sharing.

II.1 How

One has a large choice with respect to the medium that is to be used to exchange the data. Knowledge may for example be transmitted visually (e.g., with pictures and models), orally (e.g., telephone conversation), or written (e.g., a facsimile, a letter, e-mail), or by a combination of these (e.g., through video-conferencing). A further discussion of all the options is not the goal of this research. In practice, however, choosing the medium is very important because a decision with respect to the medium has stringent consequences for options in the other boxes in the framework. Indeed, for choosing a medium, one will have to keep the other questions (mentioned in the following sections) in consideration: where the data is stored, who is involved, what kind of data it is, etc.

II.2 Where

With respect to the where dimension two questions have to be assessed: where is the data located?, and what is the structure of the network?.

Network structure

Two nodes will always exist when information has to be shared: the location(s) of the data before transmission, and the location(s) of the data after transmission. Beside these nodes, other (intermediate) nodes may also be involved; for

example because they will store the information that is transmitted (temporarily or permanently).

One has to investigate which relevant nodes do exist, and whether new nodes should be added, and where they should be added. Each node may be located on the premises of the parties, or at some other location (e.g., a webfarm, external to the business relationship). The location of the nodes, of course, has consequences for the communication medium (see HOW) that can be used. We note that, in general, the communication medium also has some topology. This topology is, however, transparent. For example, when using the telephone or the Internet many switches are included in the network. For realizing data transmissions the presence of these switches is transparent. They can be seen as infrastructure.

Data location

Companies that want to share data may agree to create a replication of the data. This replication may be located outside their company or not. The replication-dimension should be seen as a continuum, from 'no replication', over 'thin replication' to 'fat replication'. Besides the data itself, data about the data can be stored too: meta-data about where the data can be found.

Data replication should be considered for all the nodes in the network. If an intermediate node is used, the node may store copies of (some of) the data. The node may then be a thin or a fat centralized datawarehouse. In case the node does not possess replications of the data itself, it can use meta-data to function as an information broker. The information broker can then act like a buffer for changes in relationships between companies. In case the counterparty in some process changes, the sending/requesting system does not need to be aware of this change: the information broker keeps track of such changes, and makes sure valid data (i.e., data from the right party) is transmitted to the right party. This is done on the basis of the meta-data the broker can investigate.

II.3 Who

The 'who question' pertains to the parties that are involved in the information exchange, and the roles they may play. Again, several issues come to the front: Who is involved? Who initiates the information exchange? and Who is authorized to ask/send/get data?

Needy/Sender/Intermediary

In every data exchange, at least two parties are involved: a party that wants to get the data (who we call 'the needy'), and a party that has to transmit the data (called 'the sender'). Besides these two parties, intermediaries may be involved in the information exchange. An intermediary may be owned by the organization of the needy, by the organization of the sender, by a third party, and by any combination of these. With 'ownership' we refer to the party who can make the

decision³ as to how the intermediary should take part in the information exchange. By including an intermediary in the exchange, a many-to-many exchange infrastructure can be set up, rather than a point-to-point infrastructure.

Push/Pull

A party can get data via a pull model or a push model.

- The pull model implies that the data is requested by one party, and the other party replies (Request/Reply).
- In the push model, the data is transmitted by the data sender automatically because the sender knows the other party is interested in the data (Publish/Subscribe). This model fits an 'event-driven' way of working (as is advocated in business practices such as Supply Chain Event Management, but also in systems development methodologies such as MERODE).

Irrespective of which model is used, we refer to the party that wants to get the data as 'the needy', and to the party that has to transmit the data as 'the sender'.

We note that if we assume that subscription in the push model cannot only be done by the information needy (but also by the information sender), the push model also allows for sending orders for example (as if the supplier of the product is subscribed for getting the order).

As stated, besides the primary needy and sender also intermediaries may be involved. The interaction between needy and intermediary, and between intermediary and sender may happen through different models. The needy may use the push or the pull model in his interaction with the intermediary, and irrespective of this choice, the intermediary may use the push or the pull model in order to get the required data in his system.

If we now consider the Where-question again, one can see that in case of the Request/Reply model, the needy can choose to make the data he received persistent or not. Irrespective of whether he did so, meta-data can be useful to find out where to request the (updates of, and additional, detailed) information. In case of the Publish/Subscribe model, meta-data is only useful for subscription purposes. Once subscribed, the meta-data is no longer useful for the subscriber, as any information that comes available will be transmitted to him. Not storing the information means the data is lost for the receiver (if the parties stick to the push model).

Choosing to replicate the data at some other location should not be done without thinking about the intermediary's ownership that is created this way. A party may actually loose the ownership over the data if a replication is stored at a location outside the company walls. This may particularly be the case if the intermediary where the replication is stored is owned by another party.

Authorization and authentication

A needy may not accept data coming from just any sender. Authorization and authentication⁴ can be needed here. Authorization and authentication are, however, also going to play a big part when turning the picture upside-down: By looking at the needy from the point of view of the sender, it is clear the sender does not want to give his data to just any party. A needy needs to be authorized data access.

Every message exchange between parties can be accepted or rejected. In the Publish-Subscribe model, if one party subscribes (be it the needy or the sender), this subscription has to be accepted by the other party. Given the fact that a subscription is considered valid by both parties, publishing data is authorized as well (authentication may still be needed). In the Request/Reply model, the sender has to assess (after authentication) whether the needy is authorized to get the information. Given the fact that the needy-system has asked the sender-system for the information, the sender is authorized by the needy to send a reply message (authentication may still be needed).

It should be noticed that giving deliberate access to one party may result in giving implicit access to many parties. This may for example be the case if the systems of the counterparty are not well secured. The idea arises that a network is only as secure as its weakest link. From the case study research done by Dynes et al. [3] at five partnering companies, it seems that managers believe that their firm's internal networks "are not at additional risk as a result of using the information infrastructure to integrate their supply chains" [3, p2]. It seemed that the firms in the study did not put big security requirements on their suppliers, although one of the firms posed it would start having requirements in the near future. This company actually believed that having a high level of information security was not merely a 'qualifier' (to be allowed to play the game), but a competitive advantage.

Still, in [4] (where Dynes presents the findings of a roundtable with a number of business leaders and academics) it is stated that in general companies are auditing the information security status of potential partners. One difficulty with such assessments is that they slow down the partnering. Besides that, it should be noticed that security is not just something that the IT department has to take care of. Employees in all parts of the organizations need to be educated (in relationship to their roles) about their responsibilities with respect to security.

Besides the unwillingly sharing of data by the new information possessor, there may also be a problem of the needy willingly sharing the data with other parties. 'Privacy' is a topic that is often mentioned in the context of partnering companies. In general, information privacy concerns the fact that individuals require that information about themselves should generally not be available to others, and that, where

³ Please note that the term 'makes the decision' is narrower than 'control'. One party may influence another party in making decisions, and another party may influence the execution of the decisions. Control is therefore often shared by many organizations. This, however, depends on the decision making process that is used, and thus varies from case to case.

⁴ Authentication has to do with determining who a user or a system is, whereas authorization is about stipulating who is allowed to access which resources [DP15].

data is possessed by another party, the individual should be able to control the data and its use to a considerable extent [2]. If a customer gives personal information to a specific company, this does not mean the customer would agree to give this information to the partners of this company. Moreover, the partners should handle the data with care, fully respecting the agreement the source organization has with its customer (although this partner may not have a direct relationship with the customer). Interestingly, privacy regulations seem to differ widely across countries [4].

As a side note, we notice that data access management requires the storage of data for authorization and authentication purposes, and that – just like for all other data – many questions have to be answered about the storage and the transmission of the access information (e.g., the information can be stored centrally or not, can be replicated or not, can be accessed directly or not, etc., see below). Based on access information, needy and senders can be further divided into categories, based on their specific permissions to create, read, update, or delete the data (see e.g., [5, and 10] for a discussion on this).

II.4 What

When exchanging data with another party, one has to make choices on a number of properties of the data itself. These properties, and the associated different options, are discussed below. First, however, we shortly have to mention a property that all data exchanges are likely to have: the data exchanged is a so-called ‘Boundary Object’; an object that links two fields which are divided by a boundary.

Boundary objects

Levina and Vaast [11] identified two basic requirements for an object to be a boundary object. First, the artefact has to acquire a local usefulness. That is, agents in each field must use and make sense of the artefact in the context of their field. Secondly, the artefact needs a common identity. To make this possible, a joint field (which serves to bridge the separate fields) must be established within which agents jointly recognize and value the artefact.

Levina and Vaast found that organizations rely on boundary spanners to establish the local usefulness and a common identity of boundary objects. The boundary spanners (1) reflect on objects from each field and on their utility within the context of the joint field, and (2) they create new artefacts and try to establish their new identity within the joint field. Then (3) they try to establish the local usefulness of these artefacts.

What (type of) information is being shared

Companies that pursue B2Bi can do this in various practices. On the one extreme, standard practices may be automated. The transmission of purchase orders may for example be automated (with no people being involved in the B2B practice). At the other extreme, the ICT systems may only be used as the start for a close collaboration: to find people in a partnering company who can help on some

practice. The information companies want to share in the latter case is typically tacit in nature, and is thus not present in computer systems. Therefore, they share other data to find out who has the necessary tacit knowledge.

In order to align the ICT with the business, one first needs to decide what *type* of data fits the *type* of the business. Only then it can be decided what data should appear in the system. This is also true in a B2B scenario. Companies have a relationship for some business reason. If this business reason is that the supplier sells some half-finished product at the cheapest rate, the data exchange will be limited to placing orders automatically. If the companies collaborate because their production processes are similar, and one can help the other out on improving its production process, the data exchange will concern the experiences, background, education, etc. of the personnel. Aligning the *type* of data with the *type* of business the companies are in, is what we call ‘high-level alignment’. Unfortunately there is no space to deal with this issue in detail. One may refer to Hansen, Nohria and Tierney [9], and to Birkinshaw and Sheehan [1] for studies within the frame of isolated enterprises (thus not B2Bi).

Batches or singles

Data that is needed by a user may be requested and transmitted as an exchange on its own. Alternatively, requests and/or replies may be grouped in batches.

Annotation

If the data is meant to be made persistent in another system, the job of storing the data usefully will be greatly facilitated if the data is annotated. That can be done by sending the data in an XML format that follows some (standardized) XML schema. To this purpose, the sender can try to push forward the degree of structuration, so as to transform unstructured data into semi-structured data.

The other way around, if the sender would not like the user to store the information, he can make things more complex to the user by not annotating the data, and sending highly unstructured documents. In this case, data that is highly structured at the sender’s site (e.g., prizes of products) may be transmitted in unstructured documents (e.g., highly graphical brochures).

As an example, a purchaser who is interested to buy products from a supplier may want to look into the supplier’s catalogue. The supplier does not want the purchaser to load the entire catalogue into his system (e.g., because the catalogue gets out-dated fast; because this would make it easy for the customer to compare prizes with competitors more easily, etc.). Still, it is important for the purchaser that when he selects the products in the catalogue, that the data on the order is made persistent in his ERP system. A solution to this problem was defined by SAP and Ariba. The Open Catalog Interface (OCI) or ‘punch-out’ solution offers a purchaser the possibility to see the catalogue via the web. The catalogue does not enter the ERP system of the purchaser. The purchaser can select the

products he wants to order in the web interface, and he can have a standard message sent to his ERP system so that the data on the desired products enters his own ERP system.

Standardization

The data may be represented in a standard or a proprietary format. For two companies to exchange data they need some agreement. This agreement may be established by a third party in neutral standards, or may be set up by the partners themselves. Of course, by choosing for a proprietary format, chances for including other parties in the data exchange later on are reduced.

We note that during the last years many standards have arisen on messages that may be exchanged between companies. While some of these standards can be used in any industry (i.e., it are 'horizontal standards'), others or tailored to a specific industry (so called 'vertical standards'). To a big extent, these standards try to bring a standard structure in the messages that are exchanged. This is pretty straightforward when dealing with common business messages such as orders and invoices (see cXML, UBL, and CBL). For files, such as patient records in the social sector, contracts in the context of legal arrangements, or curriculum vitae in the human resources, it also seems possible to find a structure. These unstructured documents can then be translated into semi-structured documents (see for example the HL7 standard, the Legal XML standard, and the HR-XML standard respectively). We note that this fact can give rise to new intermediaries in the data exchange process. For example, Oracle's iRecruitment module can be connected (through HR-XML) with providers of resume-parsing functionality or background checking functionality. If an applicant submits his resume (be it in Word, PDF, HTML, or some other format), the employer can forward this document to a 'resume parsing company' as an attachment to a HR-XML message. The resume parsing partner then unleashes his algorithms to get elements (such as address, professional experience, skills, et.) out of the unstructured document, and puts these elements in a structured HR-XML document. Information formatted in the HR-XML format may then be transmitted to a background checking partner for checking the correctness of the information in the resume (e.g., about the education). After that, the data can finally be sent to a company who is interested to hire someone with specific characteristics.

Existing or new data

The data that is being exchanged may be data that is already available at the site of the sender. However, sometimes the needy may be interested in new data. That is, he can demand/request the counterparty to create new data (e.g., new indicators for monitoring some process). Moreover, cooperating companies may start to manage data that only exists at the level of the collection of the companies, and not at the level of the individual companies. For example, if an airline company, a car rental company and a hotel chain together offer trips, each of them generally

only has information on its own sales. By putting the information together, data is available on how many customers booked an airplane seat as well as a hotel and a car. This data may then be linked to data on (individual/grouped) marketing campaigns for example to do data mining.

A side note on Web services

We note one can distinguish between 'parameter-based' Web services and 'message-centric' Web services. The first type of web services is *usually* linked with synchronous communication, realizing RPC (Remote Procedure Call)-style web services. The second type of web services is *often* related to 'asynchronous' communication [12]. The RPC-style web services may work well for some cases, but for other types of applications (e.g., when human interaction is involved at the partner side) they are less appropriate. Patil [13] states that using document-style web services has some benefits, as there are: (1) they facilitate the exchange of self-describing documents that have a business context instead of data structures that reflect application interfaces (i.e., they show the way businesses really interact with one another), and (2) they provide better insulation from changes to the underlying service because changing a few fields in a document does not break the contract between the two parties, as changing the application interface would. Consequently, the message-centric model can be used to realise a more loosely coupled integration [12].

II. 5 When

Synchronous/Asynchronous - Real-Time/Postponed

In case of the Request/Reply model, the needy may have to defer his activities until he gets a response from the information sender. This is the *synchronous* model of communication. In the *asynchronous* model, the information needy does not halt its execution. That is, in the synchronous model the sender is assumed to reply immediately, while in the asynchronous model he is not.

If the synchronous mode is desired, requests have to be dealt with in *real-time* (that is, they have to be transmitted in real-time, and be processed at the sender side in real-time). In case the asynchronous mode is chosen, requests can be dealt with in real-time or can be postponed. An intermediary may for example postpone the transmission because he wants to group all requests in a batch (see What?) before sending them to the sender. Therefore, replies may concern a single request, or a batch of requests. The real-time/postpone distinction can also be made in the Publish/Subscribe model: the data can be transmitted immediately as it comes available (an event is fired), or can be transmitted at regular time intervals irrespective of when the data came available.

II. 6 Why

In practice, the options discussed so far should be put together. Many different combinations are possible. However, not all combinations are appropriate for a given

situation. While the answers on the five questions presented so far should be chosen with attention for their interdependences, the sixth question is directional. That is, to a big extent the why-question gives direction on which options to choose in the other boxes of the framework⁵.

The why-question pertains to (1) why data is exchanged (which will not be dealt with here), and (2) why data is exchanged the way it is done.

As per the question why data exchanges happen in a specific way, a number of issues should be considered. Data is needed as the input for some task. Following Thompson [16], one would call this 'serial interdependency'. Each party who executes a task may thus have requirements on the way the exchanges should happen. Thompson, however, also mentions another type of dependency: 'reciprocal interdependency'. This refers to the case where A is dependent upon B for giving him some data, but B is also dependent upon A for giving him some data.

This results in the following viewpoints:

- The needy needs the data to execute some task. Therefore, he may have requirements pertaining to the availability of the data (see e.g. [3] for a case study on this), response time of the system, consistency and being up-to-date, ease of access vs. privacy and security, reliability, etc.
- The sender not only has to transmit the data, but also may have to create, read, update, and delete (CRUD) the data. Therefore, the sender may also have a number of requirements related to availability, reachability, ownership, etc.
- We note that an intermediary can function as a needy and as a sender. Therefore, he may have similar requirements. The requirements depend on the tasks the intermediary has to do. For example, in the health care industry one may want to run algorithms to find out about the state of the entire population in a country. This algorithm needs data that is actually dispersed over many health care institutions. If running such an algorithm would happen to be the key reason for getting into B2Bi, replication of the data to a central place may be desired.
- The reciprocal relationship is important because it may tie messages together. For example, if a customer asks A for the execution of some service, A may need the help of B. Imagine that A first sends information to B, B then requests additional information from A, A transmits this extra information, and B replies with a final answer. If the customer wants a response in real-time from A, this

has a consequence for the reciprocal relationship between A and B. The messages are tied together in a single process. A will require a real-time answer from B, and *therefore* B will require a real-time answer from A on his request for additional information.

Besides tying messages together, the fact that A is dependent upon B, and B is dependent upon A may have a consequence on the way companies deal with the interaction. No party has individual power over the other.

III. A Short Illustration

We will conclude this discussion with a short example from the health care industry (see [14, 15] amongst others). In the health care industry the idea has arisen to share information on patients among authorized institutions if a patient enters one of these organizations for help. Knowing the medical background of the patient can be very important. Because so many different institutions may have information on the patient, an institution needing information would need to contact all other institutions. One can hardly call this an efficient search. Therefore, in the Netherlands, a central point has been entered in the network where a needy can request for information. The central point itself does not have the data on the patients history. However, it has information on where information on some patient can be found. It got this information because it is subscribed with the different institutions who publish this information to the intermediary. In a similar set-up, the English central point *does* contain some of the information on the patients. That is, there is a thin replication in the English system, while there is no replication in the Dutch system.

As the Dutch central point does not possess the patient information itself, one might think the central point would answer the request by replying with the data about which institutions do have data on the patient. This is, however, not the case: the central point contacts these institutions (i.e., the single request from the requestor results in many requests from the intermediary) and groups the replies of the different institutions before transmitting the data to the needy.

Message exchanges between the different parties happen in the format described in the HL7-standard. Using a standard is important because it should be possible to flexibly change the parties that are involved in the whole set-up.

IV. Dealing with the Six Questions

The topics identified so far have been placed into six boxes. While these boxes give a nice categorization of the issues that have to be dealt with, actually doing so is not simple. This is because

- (1) many of the questions relate to both, the business and ICT side;
- (2) the answers to the questions should not only be

⁵ While decisions in the other boxes may have influence on each other, decisions in other boxes do not have consequences for the why-question. The strategy drives the choices that are made. The strategy can be driven a-priori by the many options that are available, but is not driven a-posteriori by the options that were chosen. Of course, strategies are dependent upon decisions made in the past, but a strategy that is adapted that way only takes effect in the next cycle (at time t+1) of making decisions on the other questions.

appropriate for a specific project, but should fit with the longer term strategy for these questions; and

(3) one company cannot answer the questions in isolation: answers that are formulated within an individual enterprise should fit with the way the Extended Enterprise (i.e., the collection of partnering companies) is conceived.

These three dimensions can be found in the FADEE framework we presented in [6, 7, 8] (see Figure 2).

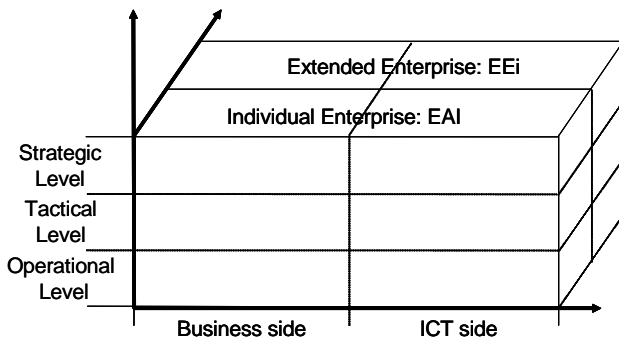


Figure 2: The three dimensions of the FADEE framework

At this point we do not want to deal in detail with the question how to bring the data-related questions into the FADEE. Rather, we give an example of the relevance of each of the dimensions.

(1) The concept of boundary objects is present at the business and at the ICT side. UBL, the Universal Business Language, for example is a standard for realizing B2Bi. As such, UBL defines seven business documents (such as 'order' and 'invoice'), and gives accompanying XML-schema definitions. While the UBL schemas are meant to be exchanged between computer systems of different companies, the documents they represent should function as a boundary object between business people as well. Therefore, specifications have been developed for automatically rendering a classic visual of the content of the XML documents, for example as a .pdf document, meant for human usage.

(2) The fact that companies should have a strategy with respect to these questions can be shown with important issues such as replication. If the strategy of the Extended Enterprise is to leave data ownership in the hands of the original owners, data replication should be limited. In the case of the health care industry in the Netherlands for example it was stated that duplicating some of the information in the central hub could be good for performance reasons. However, duplicating the information would not have fitted the strategy, which states that the individual organizations who create the information should remain the owners of this information (also making it possible to hide information at some future point in time for example).

(3) The Extended Enterprise and the companies that are part of it should be aligned. If the Extended Enterprise believes that it should be possible for other companies to easily enter the network, an individual enterprise should not

try to forge its proprietary data formats upon the other parties. Standard data formats are then the way to go.

In fact, while the concepts presented above may seem very simple at the start they become more complex when looking at them in detail. For example, what is a needy and what is a sender? Is this an entire organization? A person? A department? An ICT system? In fact, the concepts needy and sender are not fully defined until one reveals about which cell of the FADEE framework he is talking. At the strategic level, one deals with entire organizations. At the ICT side one talks about systems, not people. Etcetera. Another example would be the concept of reciprocal dependencies. While there may be a reciprocal dependency between two companies, there may be no obvious reciprocal dependency between individuals of these companies (e.g., because the needy and senders from each company belong to different departments).

V. Conclusions

In this paper, we looked at the Extended Enterprise from a data-point-of-view. First, we organized data-related issues in the simple DA (Data Aspects)-framework. While space limitations made it impossible to deal with the six cells in detail, the paper gives a nice overview of the issues that should be dealt with if companies want to share information. A full account of the complexity of dealing with the issues is made when the issues are placed in the FADEE framework.

We believe that – for practitioners – the B2Bi exercise becomes more intelligible by structuring the problem domain in categories that fit with common sense. For researchers, the framework is interesting because it offers a structure to compare different cases and to investigate why some option was chosen in a specific case.

As we stated, this paper presents research-in-progress. Our future research will result in a more complete account of the DA framework. Also, we will broaden the discussion so as to draw up a TA-framework (similar to the DA framework) covering the Task Aspects. These TA issues will then be positioned together with the DA issues in the FADEE framework.

Acknowledgments

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Biographies

Frank Goethals completed his Master studies in economics (option informatics), at the K.U.Leuven, Belgium, in 2001. He is presently researching for a PhD under the theme of 'Extended Enterprise Infrastructures'. This research is conducted at the K.U.Leuven under the guidance of

professor J. Vandenbulcke, and is financed by SAP Belgium. Frank has a strong interest in Web services technology and Enterprise Architecture, and is investigating how supply chain partners could integrate their systems efficiently and effectively

Jacques A. Vandenbulcke is professor at the Department of Applied Economic Sciences of the Catholic University of Leuven, Belgium. His main research interests are in Database management, Data modelling, and Business Information Systems. He is co-ordinator of the Leuven Institute for Research on Information Systems (LIRIS) and holder of the SAP-chair on 'Extended enterprise ICT-infrastructures'. He is president of 'Studiecentrum voor Automatische Informatieverwerking (SAI)', the largest society for computer professionals in Belgium, and co-founder and vice-president of the 'Production and Inventory Control Society (PICS)' in Belgium.

Wilfried Lemahieu holds a Ph. D. from the Department of Applied Economic Sciences of the Katholieke Universiteit Leuven, Belgium (1999). At present, he is associate professor at the Management Informatics research group of this department. His teaching includes Database Management, Data Storage Architectures and Management Informatics. His research interests comprise distributed object architectures and web services, object-relational and object-oriented database systems and hypermedia systems.

Monique Snoeck obtained her Ph.D. in May 1995 from The Department of Computer Science of the Katholieke Universiteit Leuven with a thesis that lays the formal foundations of the object-oriented business modelling method MERODE. Since then she has done further research in the area of formal methods for object-oriented conceptual modelling. She now is Associate Professor with the Management Information Systems Group of the Department of Applied Economic Sciences at the Katholieke Universiteit Leuven in Belgium. She has been involved in several industrial conceptual modelling projects. Her research interests are object oriented conceptual modelling, software architecture and software quality.

Designing And Implementing An Online WebGIS-Based Decision Support System

Lihua Zhao*, Hongwei Lu **, YouSheng Yu***

* School of Geography, Beijing Normal University, Beijing China,

** School of Marketing, The University of New South Wales, Sydney, Australia,

*** Zhongbing Geo-Informatics Engineering Co. Ltd, Beijing, China

Abstract: This paper focuses on providing a market analysis solution through designing and implementing an online decision-support system (DSS) for businesses decision makers in Tobacco industry in China. The procedure makes use of data, information and software from Web based Geographical Information Systems (GIS) to generate online analysis, mapping and visualisation systems. These procedures are integrated and synchronised with market analysis techniques and customer relationship management (CRM) systems.

By integrating these two techniques, a webGIS-based tobacco market information system is presented to demonstrate the significance of WebGIS in market analysis field. Specifically, to meet the needs of market practitioners (retailer, distributor and industry authority) in understanding the current market and sales performance, the system is designed and mainly consisted of four functional components: Communication and administration, Current market analysis, CRM (Client Relationship Management) and Sales/customer analysis, and Operational issues. From the system design and system usage perspectives, the illustration on the system architecture and the process of marketing information transmission reveals the benefits raised from this E-commerce tool to both the system users and service provider in marketing analysis. Based on this, the fusion of technology enhancement and marketing strategy in business process are called for and discussed.

Keywords: Decision Support & Group Systems, WebGIS, Market Analysis.

I. Background and Current Development of WebGIS In E-commerce

I.1 E-commerce Role in Business and Marketing

So far, Internet is becoming a global common platform where organizations and business people communicate with each other to carry out various commercial actives and to provide vale-added services [4].

With the variety applications of e-commerce in business, Feeny [3] summarizes the role of e-commerce into three perspectives: E-operations, E-marketing and E-service (see Table 1). As he says, "For traditional bricks and- mortar companies, components of e-operations and e-marketing are likely to represent immediate opportunities with real economic benefits. The e-service strategy creates a strategic

intent that will influence the evolution of the other two strategies". He predicts that e-services will be the focus of firms' business strategies in the future and the source of great potential profit; according to him, "E-services represent the ultimate aspiration of the Information Age, with their electronic orchestration of offerings that span the breadth and lifespan of a customer/client's needs within a chosen and defined market space".

Table 1. The Role of E-commerce

E-opportunity	Component
E-Operations	• Automation of administration processes
	• Supply chain reconfiguration and integration
	• Re-engineering of primary infrastructure
	• Intensified competitive procurement
E-Marketing	• Increased parenting value
	• Enhanced selling process
	• Enhanced customer/client usage experience
	• Enhanced customer/client buying experience
E-Services	• Understanding of customer/client needs
	• Provision of customer/client service
	• Knowledge of all relevant providers
	• Negotiation of customer/client requirements
	• Construction of customer/client options

(Source: Feeny, 2001)[3]

Today, e-commerce provides ready access to a vast array of information resources and facilitates the gathering of valuable knowledge and competitive intelligence. As the network of Internet users expands, marketers are increasingly turning to the Web for market research information needed for decision making [2, 13], for example, market surveys, "virtual shopping" experiments for testing new product concepts, customer satisfaction measurements, etc.

Based on internet technology, more and more techniques from the other disciplined have been integrated for e-commerce activities, for example, data-mining techniques

have been applied to Web sites for providing timely trend analysis and customer/client profiling information that is valuable in making effective marketing- mix decisions [7]. Applying GIS technology in e-commerce is another example of providing market intelligence by focusing on spatial context.

I. 2 WebGIS-based E-commerce Application

A Geographical Information System (GIS) is a digital mapping and spatial analysis system capable of assembling, storing, manipulating and displaying geographically referenced information. It helps users understand spatial relationships, enhances decision-making and solves problems more quickly [5, 10]. A Web GIS platform provides a powerful online data process and display system. The swift development Marketing Information System (MIS) or Decision Support System (DSS) enables it now becoming an important part of business life [12]. The power of a WebGIS in business decision support areas could be its ability to manage spatial data from a number of sources, to display spatial data online dynamically, and provide spatial analysis modelling and decision support scenarios.

Specifically, GIS is capable of integrating retailers' internally-generated databases (eg. CRMs) with database produced by 'external' sources using spatial proximity, GIS helps to analyse and visualise these data effectively, therefore, enhance communication and provide knowledge to decision makers for their decision making. The use of WebGIS technology to enable or facilitate the delivery of information services online has the potential to benefit both the system users and service providers alike. These benefits could be seen from the above three perspectives in Table 1. Although the significance of GIS in business world has been identified by more and more researchers and practitioners in marketing [1, 6, 14], there is not enough attention has been drawn on the application of WebGIS on marketing research, especially, from both academic and managerial perspective to explore the significance of WebGIS application in marketing analysis perspective.

Based on this, the purpose of this paper is to explore the designing and implementing the hierarchical structures and the analytical process of this WebGIS based tobacco marketing analysis system, and then further elaborate benefits of such WebGIS based E-commerce system can be made to the business world. Considering the information needs from different users, firstly and broadly, the structure design of this WebGIS-based system is illustrated in Section 2. Then, the process of information transmission in using this online MIS is explored in Section 3. Specifically, the detailed information on the functionality of the system is demonstrated in Section 4. This leads to the discussion of the benefits fetched by this system and the consideration of the future research in Section 5.

II. The Architecture and Structure of WebGIS-Based Market Analysis System

II. 1 Tobacco Industry in China & Information Need

In China, over the last decade, tobacco has perennially been the largest contributor to China's tax coffers by industry [8]. In 2003 alone, tobacco taxes nationwide totaled approximately US \$29 billion [15]. The production, marketing, and distribution of tobacco have remained under the watchful control of China's State Tobacco Monopoly Bureau [8], by considering the tobacco risk-reduction to the public health (for instance the license control in each geographical area and different type of retailers/clients). Specifically, in this information era, the role of government authority in tobacco industry has been gradually transferred to a service provider in the industry to enhance the tobacco-control and improve the efficiency of tobacco distribution and marketing.

Considering the government authority as the service provider for this market analysis system, the key users will include the Tobacco industry clients (i.e. tobacco retailers, and distributors) and industry authority itself. As the system involves the users in different geographical areas, and different levels in the administration system, thus different information are needed by different system users, which is shown in Table 2.

Table 2. Information Needed by the Different Users

System user	Information needed
Retailer	<ul style="list-style-type: none"> • Current sales of tobaccos • Spatial distribution of sales within the local area • Market share • Brand sales • Sub-category sales • Sales change • Customer (group) behaviour • Market potential in each area
Distributor	<ul style="list-style-type: none"> • As the above • The performance of covered retailer • The change of performance of covered retailer • The network of local retailers distribution • The efficient way to keep inventory and deliver tobacco to the retailers.
Industry authority	<ul style="list-style-type: none"> • As above information within industry in the context of country/regional wide • The cost and efficiency of running tobacco business • The cost and efficiency of doing market analysis

As shown in table 2, this market analysis system should

be designed not only to help the clients of industry authority (retailers/distributor) understand the geographical distribution and the behaviour of customer (i.e. the individual end-user/consumer of tobacco), but also help industry authority auditing the sales, marketing and behaviour of its clients. Consequently the system will help to improve both industry economic efficiency and public health awareness, and protect the industry from international/national threats of smoking restrictions and supporting the industry position [11].

II. 2 The Structure Design of WebGIS-based Market Analysis System

The WebGIS-based market analysis system developed provides both users and decision-makers with a flexible, problem-solving online environment with a geographic foundation. From the perspectives of the industry authority/information provider and the clients, the accurate updated data is a common fundamental issue. In order to track the market trend and collect sales-related data on a regularly (daily) base, the whole system is designed into three interrelated layers: user layer, application layer, and service layer, which is shown in Figure 1.

In computing network design, user layer is described as a client, and the other two layers within the network, which are used to store the comprehensive databases and ran more complicated applications, are described as servers.

User layer

As it is shown in Figure 1, the main tasks of the system users (retail outlets or decision makers in different level) include:

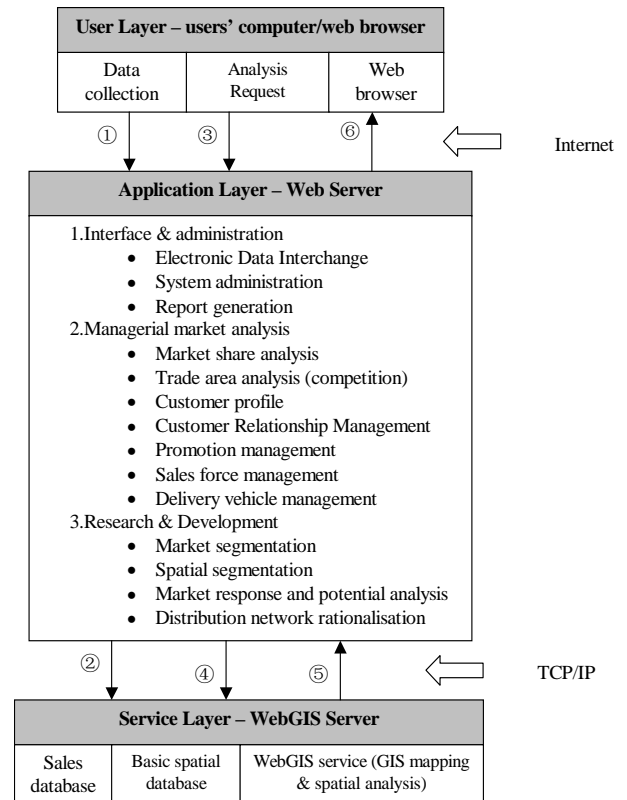
- 1) Data collection - to update their sales related data on a regular base.
- 2) Request sending - send the requests to the server about various market analyses for examining the current market performance, evaluating the market potential of a certain customer group or a target area.
- 3) Web browser - to receive and display the result of analysis from the server.

Considering the main duties of users are to provide the detail sales information, send request for the market analysis and receive the analysis results to/from a stand-alone server rather than running a comprehensive and sophisticated marketing analysis in a single computer. As the main duties at user level are simplified to the basic level, the requirements are minimised in terms of the hardware computing power and technical skill required to a user in data collection, marketing analysis and computer usage.

Application layer

To meet the variety needs from the different users, application layer is designed to provide a comprehensive marketing managerial and research analysis module.

Figure 1. The Structure of WebGIS-based Market Analysis System



(After: Lembo, 2004)

Internet is the connection link between the requests from client-side (user layer) and the result analysis provided from service-side (this application layer). The web interface & system administration tool links system user to various analytical and managerial analyses. This standardized interface and system administration tool facilitates the automation of administration processes, reduces the cost on learning and training the use of the system, and minimise expenses on maintaining and providing technical support of using the system.

As the major analysis and administration functions are pushed back, the requirement to the computing hardware, system design is quite high, since this is application-running station of interface & administration, managerial market analysis and research & development.

Service layer

The service layer consists of two key components: relational database system and WebGIS module. This relational database system stores and provides geo-referenced datasets requested by the applications in the application layer. The requested spatial analysis and geographical mapping tasks will be fulfilled by GIS module.

Specifically, relational database includes CRM (sales database) and the basic spatial database. Sales database will be updated on a regular base by the users of the system. And

basic spatial database is a pre-build database set, which contains all the relevant information about the whole study areas.

Within this relational database system, not only the comprehensive geo-referenced datasets are kept, but also, the spatial relationships among these geo-referenced datasets are stored and structured, therefore, geo-referenced information could be retrieved, aggregated, calculated based on the request from the users.

As this market analysis system is set on a spatial base, thus spatial analysis and geographical mapping will be requested by almost all the analysis. And the results of each analysis can be reported by geographical mapping. In addition, as GIS and spatial database need to work together closely, thus, this relational database system and GIS module are developed together. TCP/IP, a special language, is used to link this layer with the other (i.e. application layer)

III. The Information Process in WebGIS-Based Tobacco Market Analysis System

The above structure design provides efficient information flow, and generates useful market analysis knowledge and intelligence to be used by various users and decision makers.

Step ①: Data collecting, data entry, and data coding (E-operation)

Currently, aided by bar-code reader, the sales data on daily base could be captured and stored easily. For instance, roughly, there is 16 million sales of tobacco in Hainan province, i.e. 50 thousand sales in daily based records, which is shown in the sales scanner data records. Based on this imported scanner data, the system will automatically assort the data into pre-set standardized format for the next step analysis.

On a regular base, the users of the system within broad geographical areas update their sales data from their own computer. This update information is passed through Internet to the Web server. The electronic data interface (EDI) structures the updated information from the users in a broad geographical area in an identical format. This standardized and atomised E-operation in data entry and coding method will improve the efficiency of data collection, entry, and coding within whole industry/system.

Step ②: Sales data updating (E-operation)

Then this structured sales information is passed on to the central sales database via TCP/IP automatically.

Step ③: Analysis request sending (E-operation, E-service and E-marketing)

Based on different purposes, the analysis request is sent out from user to the web server (computer(s) in belonging to application layer). For instance, as a member of user group, user can request to update the user profile via *system administration* module.

The general marketing analysis tools can be requested by the users. As there are series inter-related analyses within web server, users can customize their request for their specific purpose and just pay for the use of their customized analysis. Consequently, reduce the cost of users and improve the efficiency of the system performance, since only the requested analyses are run on the system.

Based on result from general marketing analysis tools, the more sophisticated and specific researches can be conducted via the interactive communication between system user and this marketing analysis system. This research and strategy development module includes market and spatial segmentation, market response, retail network rationalisation and budget optimisation.

Within this application layer, it is noted the *CRM* and *delivery vehicle management* module are incorporated, thus, based on the result of customer profile, the target market will be revealed and determined. And the spatial differentiation in terms of demand can be identified. Accordingly, the promotion management can directly send out promotion letters/advertisement to the target market. And the *delivery vehicle management* can automatically coordinate the distribution schedule based on the principle of minimizing the total distribution cost by considering both the travel path distance, traffic flow and the labour cost etc. Thus, in this layer, all the functions of E-commerce, which are listed in Table 1, could be found in this system, i.e. E-operation, E-marketing and E-services.

Step ④ data communicating and result generation request

Because, the sales database and relevant spatial database are requested and incorporated during these analysis and exploration processes, the data communication occurs all the time. And at the end of analysis and exploration, the result generation request is always sent out to WebGIS server for a more vivid analytical output.

Step ⑤ GIS mapping & output exporting

Within this WebGIS server, firstly, sales database is updated and geocoded as a routine updating process. Then, the sales database will be incorporated into the Basic spatial database for spatial analysis and mapping. The detailed trading area market analysis could be found in Appendix A. The significant features of GIS module could be found not only in market share analysis, spatial segmentation, but also in distribution network rationalisation. At the end of these analyses, geographical maps will be created *within* WebGIS server. Then these maps (only the image itself) will be exported application layer, i.e. Web server.

Step ⑥ result browsing

The output image exported from WebGIS server will be packaged into a customized format in Application Layer according to the request from user and *System*

administration tools. Eventually, this formulated output will be displayed by the Internet browser in user's side.

IV. The Functional Components of the WebGIS-Based Marketing Analysis System

To meet the requirement of different users in understanding current market performance, customer behaviour, and working out the solution for daily business practice (e.g. tobacco delivery). This WebGIS-based marketing analysis system is consisted of four major functional components (shown in Table 3): A) Communication and administration, B) Current market analysis, C) CRM and Sales/customer analysis, D) Operation & Decision Support Issues.

A. Communication & administration

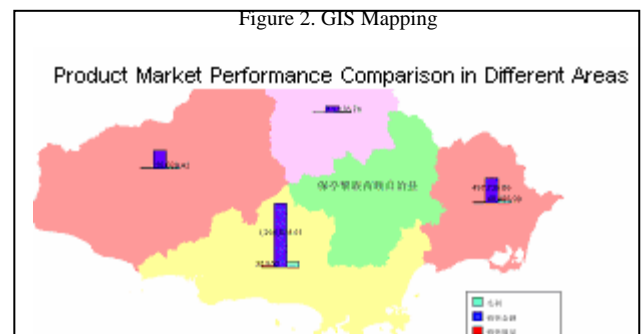
In this module, administration means the market information is periodically collected from the retail outlets, and provides system management mechanism as well. For example, as the users of system, they are authorised to logon the system to acquire the marketing information they need. However, by categorizing the user into different groups and allowing them to access information they want at different content levels, Thus, not only this mechanism can reduce the cost of system user, but also improve the speed of whole system operation. 'Information user group management' function can easily match customer identity with the customized information will be offered.

With this WebGIS-based system, not only the system could incorporate and integrate the data from different sources by GIS Database functions, but also geographical mapping improve the communication efficiency and effectiveness by putting the intensive marketing information into easy to understand map format. With maps, the enormous and complicated marketing analysis and spatial modelling results can be vividly presented, the presentation can help system users and/or decision-makers easily link or integrate their considerable influencing factors (eg, experiences, consciousness) and the complicated analysis results together. Thus, maps have the potential to integrate the human intelligence with the Internet-based powerful computing capacity to achieve the communication and analysis efficiency and effectiveness. For instance, in Figure 2, while the colour base map shows the level of total sales in each area, the three bar chart figure in each area indicated the level of detail sales performance, i.e. sales profit, total quantity sales, total sales amount. This map output can help users/decision makers to understand sales performance in different regions by simply glancing.

Table 3. Functional component of the WebGIS-based MIS

Functional module	Function -classification
A. Administration & Communication	<ul style="list-style-type: none"> System administration System tool Information user group management Information management Information collection and assortment Internal management
B. Current market analysis	<ul style="list-style-type: none"> Total sales By the class of quality By sub-category By produce origin By functional specification By brand Sales spatial distribution pattern
C. CRM & Sales/customer analysis	<ul style="list-style-type: none"> CRM Performance analysis Customer value evaluation Customer audit system
D. Operational / Decision support issues	<ul style="list-style-type: none"> Logistic management Area-based optimisation retail outlet rationalization

Figure 2. GIS Mapping



B. Current market analysis

As the intensive marketing information is organised in GIS-based relational database, thus, a variety combination of marketing analysis can be offered by the system to meet the needs of different users under the different conditions, which is shown in Table 3.

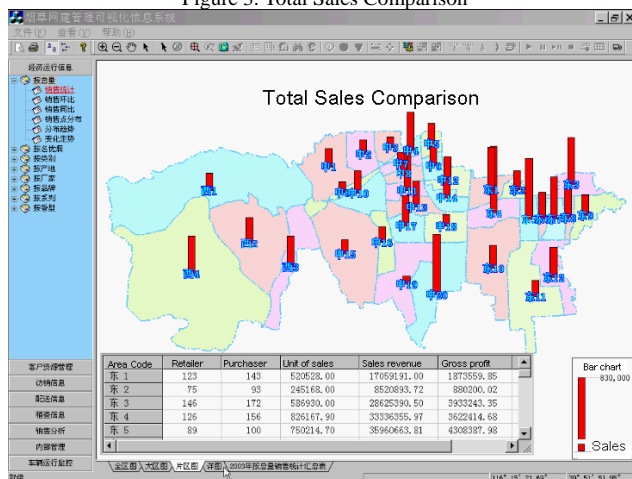
By compacting and integrating the various market analysis and knowledge discovery module on customer study, market segmentation, spatial segmentation, 'if-then' multi-criteria scenario exercise, and optimisation/operation research into the analytical system, it could provide the chance of mass-customisation, i.e. the user can select and pay for the analysis based on their needs and preference. Also, it is noted, this standardized managerial market analysis and research & development module not only can provide the valuable information on current sales pattern, demand distribution, market pattern in a standard format within various time and spatial context, but also it could

improve the comparability of sales and market in different places and time frames. In addition, this standardized analytical module makes it easier and cheaper to update the entire analytical system and functions without big changes in user-side. Consequently, reduce the overall cost of market analysis within the whole user group or industry.

C. CRM & Sales/customer analysis

This GIS-based CRM system can go beyond the functionality provided by general CRM system, i.e. the performance, value and preference of each customer. In addition, the CRM system links customer with geography. Thus, the system user could get additional information of the spatial distribution and spatial location of the high value/potential areas/clients and the comparison of the market performance could be revealed, which is shown in Figure 3.

Figure 3. Total Sales Comparison



Not only the sales statistics across a broad geographical area could be displayed in a single map, but also the performance of each individual retail outlet could be linked and examined, which is shown in Figure 4. This can facilitate the target market planning in the organization.

Figure 4. Link to Individual Retail Outlet

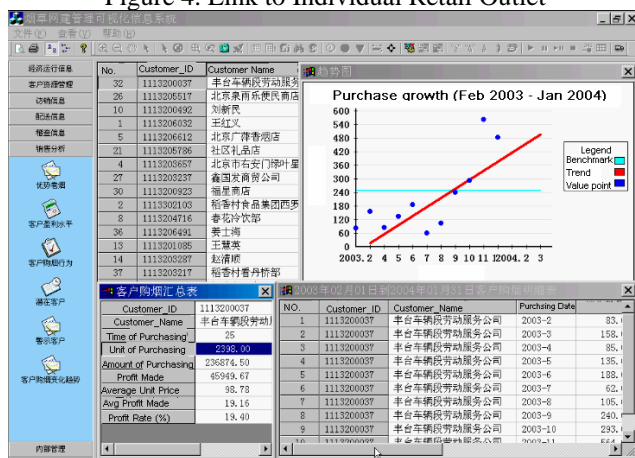


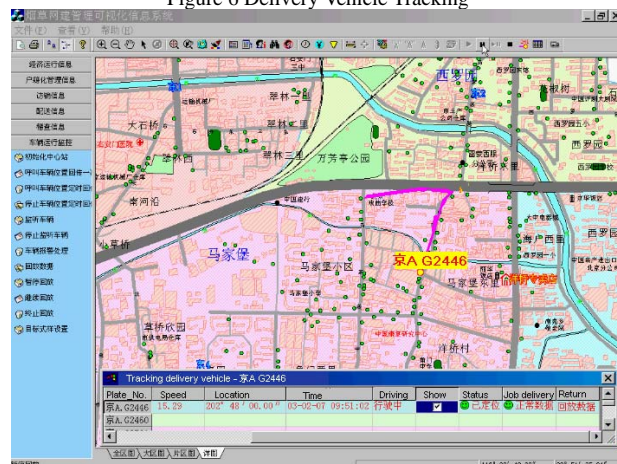
Figure 5 Delivery Vehicle Management Component



D. Operation and Decision Support Issues

Different from the general MIS, this GIS-based DSS provide a special facility in spatial analysis. Thus, it enables the decision-makers conduct the operational planning on *delivery vehicle management*, *area-based optimisation*, and *retail outlet rationalization*. For example, based on spatial analysis results, that is shown in Figure 5, the real-time delivery vehicle tracking function provides decision makers a practical tool to coordinate the members in the distribution channel, accordingly, improve the delivery efficiency by incorporating the local traffic information, which is shown in Figure 6.

Figure 6 Delivery Vehicle Tracking



As it is mentioned above, to meet the needs of the system users in different levels, the Internet-based technology provides significant advantages. These advantages could be perceived clearly by examining on the architectures of this WebGIS-based DSS.

V. Discussion

V. 1 Benefits Raised from WebGIS-Based System Design

By fulfilling the role of E-commerce (E-operating, E-marketing and E-service), which is shown in the above illustration, it is shown that this WebGIS-based tobacco market analysis system can help in improving the market analysis functionality, reducing the cost, enhancing the operational efficiency, and increasing the adaptability of the system:

1) *Improving the functionality*, as it is shown above, by developing the applications into a few different modules, more functionalities are provided, thus it could match the different demand of marketing analysis. Within this open system (to every user in a broad geography areas, and decision-makers in different levels and departments), the horizontal and vertical integration of available datasets make the prediction accuracy improved. Thus, the marketing analysis and exploration will be conducted based on longitudinal data rather than cross-section data, and a spatial continuous area rather than limited spatial points. In addition, not only the sales-related dataset is incorporated, but also, the geo-referenced data is intensively used. Accordingly, the information provided by this system represents the spatial-temporal dynamics, i.e. close to the spatial reality, which lead to more accurate result for market analysis. More importantly, the system is available online and maintains an open and fair market place to member in this industry. In addition, as the GIS-based exploratory researching modules are incorporated, the multi-criteria based 'if-then' scenario exercise will help the users simulate the spatial reality. These will contribute the improvement on the quality of marketing analysis and prediction.

2) *Reducing the cost*, by modelling the process and analytical modules into a hierarchy structure, linking the computers and analysis together via Internet, this system reduces the workload on each single computer. This structured design reduces the technical and skill requirements on user side and it makes the marketing practitioners feel easier with market spatial analysis. Also, as the users only pay for the customized services (analysis) and need not to run it on their machines, thus it reduces the cost for the users. In addition, the standardised and automated process of data collection, transaction and analysis extremely reduce the cost and effort put in by comparing the conventional approaches. From the users' perspective, the customized functions and analyses provide the chance to minimum their budget on the service.

3) *Enhancing the operational efficiency*: The analytical system interoperation and working efficiency for administrating and communicating are improved by a series of standardized and automated process and approaches. By organising the marketing analysis into different modules, it facilitates the users to choose and customized the modules they want and the order to do the analysis. Thus, in one hand this flexibility will lead to the budget saving, on the other hand, this flexibility could increase the customer participation and remove the customer resistance to adopt the service. By pushing the analysis layer and database layer backwards, it standardises the content format and database

manipulation process and market analysis. Thus, this structure makes it easier to transform the whole system into the new operating system, database management system and networking structure, i.e. improving the compatibility.

4) *Improving relationship* between the system users (decision-makers in different levels) and *the adaptability*, by working under online open environment, the sales-related figures and analyses could be updated automatically in the same format and/or under the request of the users, this will reduce and remove the suspicion and misunderstanding, increase trust. As the analytical module is removed from user layer, it reduced the knowledge and skill requirement level of using the specific software and makes the marketing analysis job easier. And the visualization of GIS increase the level of interesting and reduce the complexity.

V. 2 Future – the fusion of marketing practice and technology transformation

1) *Technology → service: WebGIS, Customer-based decision support system & service*

WebGIS can help integrate the spatial information and bridge human analytical skills with their machine-processability. As it is shown above, the architecture of WebGIS-based DSS provides the possibility to solve the technique-oriented problems, i.e. the appropriate GIS services (both spatial information and analysis) could be requested from and delivered to the users who have different GIS skills to match their needs.

Currently, Internet accelerates the integration of information in both horizontal (spatial) and vertical (temporal) dimensions. The extensive information extends decision-makers' scope in one hand, in the other hand the overload and under-utilized data confuse and frustrate decision-makers' motivation and interest. However, the mechanism of WebGIS provides customized decision support system based the client-server structure, 'if-then' scenario spatial analysis and vividly computer mapping. Thus, it (WebGIS) turns this desktop-based software or system (i.e. GIS) into a Web-based service. During this process, the emerging/new role of marketing could be seen. Therefore, in this field (WebGIS in marketing), the critical thing goes beyond the functionality of WebGIS could provide. Also, when, what and how to provide these information/solution to the decision-makers in different level become the other important thing. And this directly relates to the marketing strategy on subscription of system usage.

2) *Service → technology: The role of service provider and its marketing strategy*

When market analysis is taken as a service, the standardization of spatial data used, the system tool for spatial analysis in an open GIS environment is requested. As the standardization can significantly improve the inter-operationality, it will improve the efficiency from the whole system perspective. As WebGIS is turning this market analysis system into a service, then the concept of

coordination in terms of the relationship within client-server and the net of computers will become a critical issue. Then from a technology perspective, if the client-side strategy should be adopted or the server-side strategy should be adopted will become the other issue in this field. With client-side strategy, the enhancement in client-side infrastructure will be improvement, thus it can speed up data manipulation and the interaction between user and system. However, the requirement of the users' computing/GIS skill will be very high. On the other side, if the server-side strategy is adopted, the requirement of users' skill will be reduced, while the requirement of the server-side will be highlighted.

In sum, the swift development of information technology (e.g. Internet) has brought the revolution in marketing; on the contrary, the shift of marketing's role in the new technology environment accelerates the evolution of information technology. From both technology and marketing perspective, how can we utilize the available techniques, resource and marketing strategies to improve the business practice is becoming a hot topic in both academic and practice field.

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The FZ Strategy to Compress the Bitmap Index for Data Warehouses*

Ye-In Chang, Chien-Show Lin, and Hue-Ling Chen
Dept. of Computer Science and Engineering
National Sun Yat-Sen University, Kaohsiung, Taiwan, R.O.C
E-mail: changyi@cse.nsysu.edu.tw
Tel: 886-7-5254350 Fax: 886-7-5254301

Abstract: Data warehouses contain data consolidated from several operational databases and provide the historical, and summarized data which is more appropriate for analysis than detail, individual records. Fast response time is essential for on-line decision support. A bitmap index could reach this goal in read-mostly environments. For the data with high cardinality in data warehouses, a bitmap index consists of a lot of bitmap vectors, and the size of the bitmap index could be much larger than the capacity of the disk. The WAH strategy has been presented to solve the storage overhead. However, when the bit density and clustering factor of 1's increase, the bit strings of the WAH strategy become less compressible. Therefore, in this paper, we propose the FZ strategy which compresses each bitmap vector to reduce the size of the storage space and provide efficient bitwise operations without decompressing these bitmap vectors. From our performance simulation, the FZ strategy could reduce the storage space more than the WAH strategy.

Keywords: bitmap index, compress, data warehouse, OLAP, storage.

I. Introduction

The *Data Warehouse* (DW) is a subject-oriented, integrated, time-variant, and non-volatile collection of data in support of management's decision-making process. In other words, a DW is large, special-purpose database that contains data integrated from a number of independent sources, supporting clients who wish to analyze the data for trends and anomalies. The process of analysis is usually performed with queries that aggregate, filter, and group the data in a variety of ways. OLAP is designed to provide aggregate information that can be used to analyze the contents of databases and data warehouses. Because the queries are often complex and the warehouse database is often very large, processing the queries quickly is a critical issue in the warehousing environment.

The read-mostly environment of data warehousing makes it possible to use more complex indexes to speed up queries than in situations where concurrent updates are present [19]. Bitmap indexing has been touted as a promising strategy for processing complex adhoc queries in read-mostly environments, like those of decision support

systems. Most of the major commercial database systems now support some form of a bitmap index. A significant advantage of bitmap indices is that complex logical selection operations can be performed very quickly, by performing bitwise AND, OR, and NOT operations.

Data warehouses are essential for modern business to support the decision making. For various applications in data warehouses, where most of the attributes have high cardinality, the classical bitmap index produces one bitmap for each distinct value of the attribute being indexed [4] [5] [6] [8] [11] [13] [14] [15] [16] [17] [18] [19]. The size of the indices could be much larger than the size of the dataset. The main advantage for using a compressed bitmap index is to reduce the space requirement. However, the bitmaps from the bitmap indices are often very sparse; that is, they contain mostly zero bits. Moreover, most of the generic compression algorithms do not support fast bitwise logical operations, the compressed bitmap indices are usually slower in processing queries than their uncompressed counterparts. To increase the efficiency of query processing, a number of specialized compression algorithms have been developed [1][7][12][17][18][21][22]. The Byte-aligned Bitmap Code (BBC) is an example of such a strategy [1]. This strategy permits efficient operations without decompression, thereby reducing both the disk space requirement and the memory requirement for performing operations. Another specialized compression strategy called the Word-Aligned Hybrid run-length code (WAH) [21] is an efficient strategy that significantly outperforms BBC.

The WAH strategy [21] has been presented to solve the storage overhead. The main advantage of the WAH strategy is that compressed indexes are much smaller than the uncompressed ones and the average processing time is about the same [22]. However, when the bit density and clustering factor of 1's increase, the bit strings of the WAH strategy become less compressible. Therefore, we propose the Filtering-Out-Zeros (FZ) strategy to compress each bitmap vector to reduce the size of the storage space. The basic idea of the FZ strategy is to remove some continuous 0's in the bitmap vector, since there often exist large amount of 0's in the bitmap vector. For the bitmap vector with 128 bits (as shown in Figure 1-(a)), after compression, our FZ strategy stores only 40 bits (as shown in Figure 1-(b)), as compared to 96 bits in WAH strategy (as shown in Figure 1-(c)), where the length of the basic unit for compressing in FZ strategy is eight bits and that in WAH strategy is a word (= 32 bits).

run-length encoding and the literal strategy. There are two types of words in WAH: *literal* words and *fill* words. WAH uses the most significant bit of a word to distinguish between a literal word (0) and a fill word (1). This choice allows one to easily distinguish a literal word from a fill word without explicitly extracting the bit. The lower bits of a literal word contain the bit values from the bitmap. The second most significant bit of a fill word is the fill bit and the lower bits store the fill length. WAH imposes the word-alignment requirement on the fills, it requires that all fill lengths be integer multiples of the number of bits in a literal word. The word-alignment ensures that logical operation functions only need to access words not bytes or bits.

Figure 3 shows a WAH bit vector representing 128 bits. In this example, each computer word contains 32 bits. Each literal word stores 31 bits from the bitmap and each fill word represents a fill with a multiple of 31 bits. If the machine has 64-bit words, each literal word would store 63 bits from the bitmap and each fill would have a multiple of 63 bits. The second line in Figure 3 shows how the bitmap is divided into 31-bit groups and the third line shows the hexadecimal representation of the groups. The last line shows the values of the WAH words. The first three words are normal words, two literal words and one fill word. The fill word 80000002 indicates a 0-fill of two-word long (containing 62 consecutive zero bits). Note that the fill word stores the fill length as two rather than 62. In other word, we represent the fill length by multiples of the literal word size. The fourth word is the active word that store the last few bits that can not be stored in a normal word, and another word (not shown) is needed to stores the number of useful bits in the active word. Each WAH word (last row) represents a multiple of 31 bits from the bit sequence, except the last word that represents the four leftover bits.

128 bits	1, 20*0, 3*1, 79*0, 25*1			
31-bit groups	1, 20*0, 3*1, 7*0	62 * 0	10 *0, 21 *1	4 *1
Group in hex	40000380	00000000	00000000	001FFFFF 0000000F
WAH (hex)	40000380	80000002	001FFFFF	0000000F

Figure 3: A WAH bitmap vector

III. The Filtering-Out-Zeros (FZ) Strategy

A bitmap index consists of a set of bitmap vectors and the size of the bitmap index could be much larger than that of the disk. This is especially true for scientific databases where most of the attributes have high cardinality. The WAH strategy [21] has been presented to solve the storage overhead. The main advantage of the WAH strategy is that compressed indexes are much smaller than the uncompressed ones and the average processing time is about the same [22]. However, when the bit density and clustering factor of 1's increase, the bit strings of the WAH strategy become less compressible. Take Table 1 as an example, we observe an interesting property that there are magnificent continuous zeros in the bitmap index. If we can filter out the

consecutive 0's and only record the rest of bits, the storage space of the bitmap index could be reduced.

Table 1: An example of the range-based bitmap index

raw data	14, 16, 10, 17, 9, 16, 10, 12, 15, 21, 22, 12, 19, 15, 14, 19
Range < 12 Bitmap Vector 1	0 0 1 0 1 0 1 0 0 0 0 0 0 0 0 0
12 ≤ Range < 15 Bitmap Vector 2	1 0 0 0 0 0 0 1 0 0 0 1 0 0 1 0
15 ≤ Range < 18 Bitmap Vector 3	0 1 0 1 0 1 0 0 1 0 0 0 0 1 0 0
18 ≤ Range Bitmap Vector 4	0 0 0 0 0 0 0 0 0 1 1 0 1 0 0 1

To reduce the storage space of the bitmap index, we present the Filtering-out-Zeros (FZ) strategy. We take bitmap vector 4 in Table 1 as an example to illustrate the FZ strategy. First, we divide the total 16 bits into 2 bit strings, i.e., [00000000 01101001], and the length of each bit string is 8. Next, the first bit string includes only consecutive 0's, and the second one includes 1's. Therefore, we record the first bit string by 0, and the second one by 1, i.e., the first two bits in [01 01101001]. We still record the whole bits of the second bit string, [01101001], i.e., the last eight bits in [01 01101001]. Finally, the original bitmap vector 4 [00000000 01101001] has been stored as [01 01101001] after the process of the FZ strategy. In this example, the FZ strategy reduces the storage cost from 16 bits to 10 bits.

Let's take another example shown in Table 2 to describe the FZ procedure in Figure 4. The variables used in the FZ strategy is shown in Table 3. In Table 2, the bitmap vector of raw data contains 48 bits, and every 8 bits among these 48 bits construct a bit string. Therefore, there are $w=n/BL=48/8=6$ bit strings, where n is the number of the bits in each bitmap vector and BL is the length of the bit string. We use an array *NZflag* to record whether the bit string includes only consecutive 0's or not. The first, third, and 4th bit strings include only consecutive 0's in this example, and the first, third, and 4th bits of array *NZflag* are set to 0. The rest of bits of array *NZflag* are set to 1. The array *NZflag* is [010011] as shown in Table 2. According to *NZflag*, we know which bit string includes some 1's. Then, we use another array *NZString* to record the whole bits of the bit strings that include 1's. In Table 2, array *NZString* records 3 bit strings that are composed of 0's and 1's.

Table 2: An example of the FZ strategy

raw data	00000000 10000000 00000000 00000000 11110000 10101000
NZflag	010011
NZString	10000000 11110000 10101000

```

Procedure FZ(n, BL);
begin
  w :=  $\lceil n/BL \rceil$ ;
  let n bits be [a1, ..., an];
  set the non-zero-flag array NZflag to zero;
  for i := 1 to n do
    begin
      if (ai = 1) then
        begin
          j :=  $\lceil i/BL \rceil$ ;
          NZflag[j] := 1;
          put the jth part into the non-zero-string
          NZString;
          i := BL * j;
        end;
      end;
    end;
  end;

```

Figure 4: The *FZ* procedureTable 3: Variables used in the *FZ*, *FZ_Retrieve*, *FZ_AND*, and *FZ_OR* procedures

Variable	Description
<i>n</i>	The number of records
<i>BL</i>	The length of each bit string
<i>w</i>	The number of bit strings
<i>NZflag</i>	The array that records whether the bit string includes only consecutive 0's or not
<i>NZString</i>	The array that records the whole bits when the bit string includes 1's
<i>a_i</i>	The <i>i</i> th bit of a bitmap vector
<i>temp</i>	The array that records the bit string
<i>finalNZflag</i>	The array that records the result of <i>NZflag</i>
<i>finalNZString</i>	The array that records the result of <i>NZString</i>

```

Procedure FZ_Retrieve(n, BL, NZflag, NZString);
begin
  for i := 1 to  $\lceil n/BL \rceil$  do
    begin
      j := 0;
      if (NZflag[i] = 1) then
        begin
          j := j + 1;
          for k :=  $8 * (j - 1)$  to  $(8 * j - 1)$  do
            begin
              if (NZString[k] = 1) then
                retrieve the  $(8 * (i - 1) + k)$ th data
                of records;
              end;
            end;
          end;
        end;
      end;
    end;
  end;

```

Figure 5: The *FZ_Retrieve* procedureTable 4: An example of the *FZ_Retrieve* strategy

raw data
00000001 00000000 00001000
00000000 00000000 10100000
NZflag
101001
NZString
00000001 00001000 10100000

Figure 5 states how to retrieve data from the compressed bitmap index. For example, shown in Table 4, there are 4 1's in the bitmap vector of raw data. After the process of the *FZ* strategy, the resulting arrays, *NZflag* and *NZString*, are shown in Table 4. Array *NZString* records those 4 1's. We use the array *NZflag* to calculate the position of 1's. The formula is $8*(i-1)+k$, where *i* is the position of the *i*th bit string that contains 1's, and *k* is the *k*th 1's in this bit string. Therefore, the positions of the 4 bits are 8 ($=0*8+8$), 21 ($=2*8+5$), 41 ($=5*8+1$), and 43 ($=5*8+3$), respectively. According to the calculation, we directly retrieve the 8th, 21th, 41th, and 43th records, respectively.

A significant advantage of bitmap indices is that complex bitwise operations can be performed very quickly, such as bitwise AND, OR, and NOT operations. Therefore, we explain the bitwise operations, including *FZ_Retrieve*, *FZ_AND*, and *FZ_OR*, on bitmap vectors which are stored after the process of the *FZ* strategy.

Figure 6 illustrates how to perform an *FZ_AND* operation on those two compressed bitmap vectors. The variables used in *FZ_AND* operation are shown in Table 3, and the *FZ_AND* procedure is shown in

Figure 7. The bitmap vector in Table 2 is recorded by *NZflag1* and *NZString1*, and the bit vector in Table 4 is recorded by *NZflag2* and *NZString2*. First, we get the *finalNZflag*=[000001] by *NZflag1*=[010011] AND *NZflag2*=[101001], as shown in the left part of Figure 6-(a). Next, according to the position of 1's in *finalNZflag*, we retrieve the corresponding bit strings *temp1* and *temp2* in *NZString1* and *NZString2*, respectively, and add *temp3* into *finalNZString*, where *temp3* = *temp1* AND *temp2*. Since the 6th bit of *finalNZflag* in Figure 6-(a) is 1, we retrieve the bit string related to the 6th bit in *NZString1* from *NZString1*, [10101000], to *temp1*, and that in *NZString2* from *NZString2*, [10100000], to *temp2*, as shown in Figure 6-(b). After getting *temp1* and *temp2*, we perform an AND operation on them, i.e., *temp3* = [10101000] AND [10100000] = [10100000], as shown in Figure 6-(c), and add the bit string [10100000] into *finalNZString*, as shown in Figure 6-(d). After the process of the *FZ_AND* operation, we have *finalNZString* equal to [10100000], as shown in Figure 6-(d).

This strategy provides efficient bitwise operations without decompression, which reduces both the requirement of the disk space and the memory space for performing bitwise operations. In this example, we perform 4 ($=6+8$) bitwise AND operations on them, where *finalNZflag* includes 6 bits, and *finalNZString* includes 8 bits. If we do not use the compressed bitmap vectors, we need to retrieve

48*2=96 bits and perform 48 bitwise AND operations.

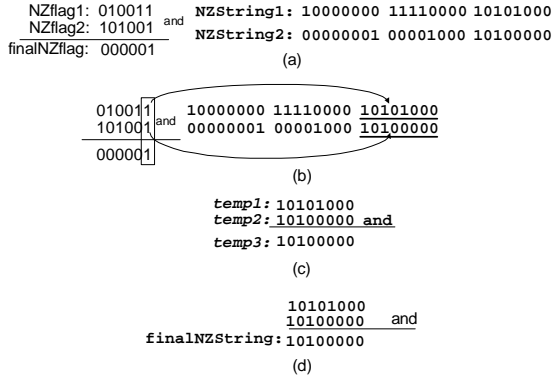


Figure 6: A bitwise FZ_AND operation on two compressed bitmap vectors by the FZ strategy: (a) the result of *finalNZflag*; (b) the bit string related to the bit in *NZString1* and *NZString2* from *NZflag1* and *NZflag2*; (c) *temp3* = *temp1* AND *temp2*; (d) the result of *finalNZString*.

```

Procedure FZ_AND(n,BL);
begin
    finalNZflag := NZflag1 AND NZflag2;
    w :=  $\lceil n/BL \rceil$ ;
    for i := 1 to w do
        begin
            if (NZflag1[i] = 1) then j := j + 1;
            if (NZflag2[i] = 1) then k := k + 1;
            if (finalNZflag[i] = 1) then
                begin
                    for p := BL * (j - 1) to (BL * j - 1) do
                        add NZString1[p] into temp1;
                    for q := BL * (k - 1) to (BL * k - 1) do
                        add NZString2[q] into temp2;
                    end;
                    temp3 := temp1 AND temp2;
                    add temp3 into finalNZString;
                end;
        end;
    end;

```

Figure 7: The FZ_AND procedure

Figure 8 illustrates how to perform a bitwise FZ_OR operation on those two bitmap vectors. We take the same two bitmap vectors, as shown in Figure 6, to perform the FZ_OR operation. The variables used in the FZ_OR operation are shown in Table 3, and the FZ_OR procedure is shown in Figure 9. First, we get *finalNZflag*=[111011] by *NZflag1*=[010011] OR *NZflag2*=[101001], as shown in the left part of Figure 8-(a). Next, according to the position of 1's in *finalNZflag*, the first, second, third, 5th, and 6th bits, we retrieve the corresponding bit strings. There are three cases according to *NZflag1* and *NZflag2*. In Case 1, the first bit of *NZflag1* is 0 and the first bit of *NZflag2* is 1. We retrieve the bit string [00000001] related to the first bit in *NZflag2* from *NZString2*, as shown in Figure 8-(b), and add the bit string into *finalNZString*, as shown in the first 8-bit string of Figure 8-(f). In Case 2, the second bit of *NZflag1* is 1 and the second bit of *NZflag2* is 0. In this case, we retrieve the bit string [10000000] related to the second bit in *NZflag1* from *NZString1*, as shown in Figure 8-(b), and add the bit string into *finalNZString*, as shown in the second 8-bit string of Figure 8-(f). In Case 3, the sixth bit of *NZflag1* is 1 and the sixth bit of *NZflag2* is also 1, we retrieve the bit string

temp1 ([10101000]) related to the bit in *NZflag1* from *NZString1*, and the bit string *temp2* ([10100000]) related to the bit in *NZflag2* from *NZString2*, as shown in Figure 8-(d). We finally add *temp3* into *finalNZString*, where *temp3* = *temp1* OR *temp2*, as shown in Figure 8-(e). After eight iterations, the result *finalNZString* is shown in Figure 8-(f).

In this example, we retrieve 6*8=48 bits, and perform 14 (=6+8) bitwise OR operations, where *finalNZflag* includes 6 bits, and *finalNZString* includes 8 bits in Case 3. If we do not use the compressed bitmap vectors, we need to retrieve 48*2=96 bits, and perform 48 bitwise OR operations.

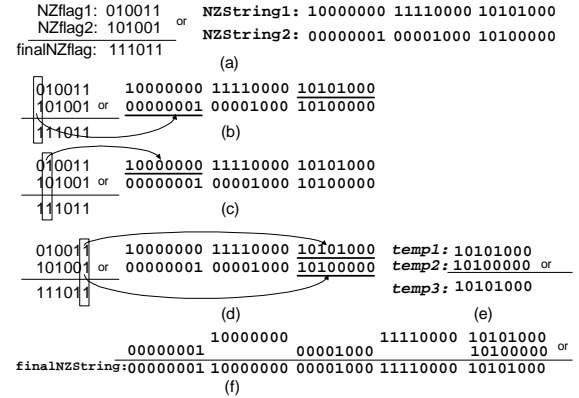


Figure 8: A bitwise FZ_OR operation on two compressed bitmap vectors by the FZ strategy: (a) the result of *finalNZflag*; (b) the bit string in Case 1 is retrieved; (c) the bit string in Case 2 is retrieved; (d) the bit strings in Case 3 are retrieved; (e) *temp3* = *temp1* OR *temp2*; (f) the result of *finalNZString*.

```

Procedure FZ_OR(n,BL);
begin
    finalNZflag := NZflag1 OR NZflag2;
    w :=  $\lceil n/BL \rceil$ ;
    for i := 1 to w do
        begin
            if (NZflag1[i] = 1) then j := j + 1;
            if (NZflag2[i] = 1) then k := k + 1;
            /* Case 1 */
            if (NZflag1[i] = 0 and NZflag2[i] = 1)
                then
                    begin
                        for q := 8 * (k - 1) to (8 * k - 1) do
                            add NZString2[q] into finalNZString;
                        end;
                    end;
            /* Case 2 */
            if (NZflag1[i] = 1 and NZflag2[i] = 0)
                then
                    begin
                        for p := 8 * (j - 1) to (8 * j - 1) do
                            add NZString1[p] into finalNZString;
                        end;
                    end;
            /* Case 3 */
            if (NZflag1[i] = 1 and NZflag2[i] = 1)
                then
                    begin
                        for p := 8 * (j - 1) to (8 * j - 1) do
                            add NZString1[p] into temp1;
                        for q := 8 * (k - 1) to (8 * k - 1) do
                            add NZString2[q] into temp2;
                        temp3 := temp1 OR temp2;
                        add temp3 into finalNZString;
                    end;
                end;
        end;
    end;

```

Figure 9: The FZ_OR procedure

IV. Performance Study

The parameters used in the performance model for the FZ strategy is shown in Table 5. Basically, we generated num bits, 1's or 0's, as the bitmap vector and this bit string is controlled by two parameters, the bit density and the clustering factor [21]. The performance measure in evaluating those strategies is the length, Len , of the bit sting after it is compressed. We plotted the average length of each bit string from experiments, and conducted 1000 experiments for each average value. The experiments were run on a Pentium 4 1.6 GHz, 256 MB of main memory, and running jdk 1.4.2 and Windows XP.

For the simulation results, the number of bit string, num , is bounded by 20000. In the figures to be presented as follows, the curves corresponding to the WAH and FZ strategies by changing different parameters are labeled as WAH and FZ, respectively. In Figure 10, Figure 11, and Figure 12, we compare the length of the bit string after it is compressed.

Table 5: Parameters used in the WAH and FZ strategies

Parameter	Description
num	The number of bits in the bit string
d	The fraction of bits of 1's
cf	The upper bound of the range of 1's

Figure 10 shows the length of bit strings for different $num=10000, 12000, 14000, 16000, 18000, 20000$. Each data point in this figure represents the average length of bitmap vectors with the same bit density ($= 0.01$) and the same clustering factor ($=1$). The resulting lengths constructed from both the WAH and FZ strategies increase when num increases. However, the length of the bit string compressed by the WAH strategy is 2 times larger than that compressed by the FZ strategy.

Figure 11 shows the length of bit strings for different values of density $d=1/500, 1/200, 1/100, 1/50, 1/20$, where $num=10000$ and $cf=1$. As the bit density increases form $1/500$ to $1/20$, the bit strings become less compressible and it takes more space to represent them after the compression. Moreover, the FZ strategy is more suitable for the case with the high density.

Figure 12 shows the length of bit strings for different clustering factors $cf=0.2, 0.4, 0.6, 0.8, 1$, where $num=10000$ and $d = 0.01$. The clustering factor, cf , is the fraction of the upper bound of the range of 1's. For example, when $cf=0.2$, the bits of 1's only exist from the first to 2000th bits in the bit string with 10000 bits. In other words, the bits of 1's are highly concentrated. As cf increases from 0.2 to 1, the bit string of the WAH strategy becomes less compressible and that of the FZ strategy still could be compressed well.

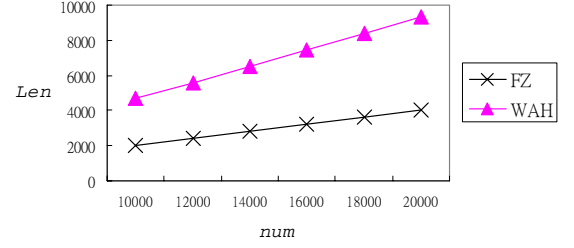


Figure 10: A comparison of the Len for the WAH and FZ strategies by using different numbers of bits in a string (num)

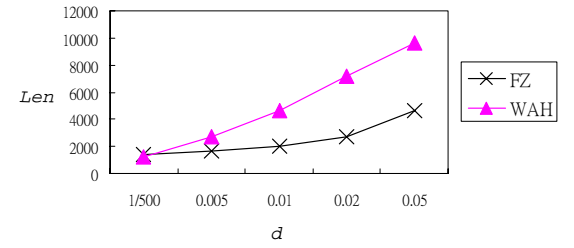


Figure 11: A comparison of the Len for the WAH and FZ strategies by using different values of density (d)

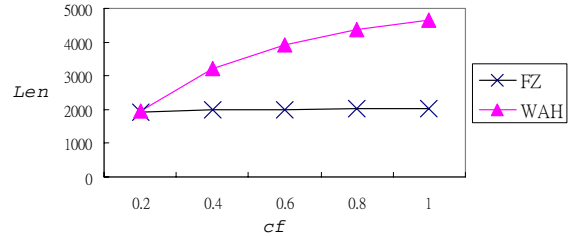


Figure 12: A comparison of the Len for the WAH and FZ strategies by using different clustering factors (cf)

V. Conclusion

To reduce the storage of the bitmap index, in this paper, we have proposed the FZ strategy which compress the bitmap vector by filtering out many zeros. We have studied the performance of our FZ strategy, and have compared it with the WAH strategy by simulation. From the simulation results, we have shown that the FZ strategy can reduce the storage cost more than the WAH strategy.

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Feature Reduction for Product Recommendation in Internet Shopping Malls

Hyung Jun Ahn*, Jong Woo Kim **

* hjahn@waikato.ac.nz, Department of Management Systems,
Waikato Management School, University of Waikato, New Zealand
** Department of Management, Hanyang University, Seoul, Korea

Abstract: One of the widely used methods for product recommendation in Internet shopping malls is matching product features against customers' profiles. In this method, it is very important to choose suitable set of features for recommendation efficiency and performance, which has, however, not been rigorously researched so far. In this paper, we build a data set collected from a virtual Internet shopping experiment and adapt and apply feature reduction techniques from pattern matching and information retrieval fields to the data to analyze recommendation performance. The analysis shows that the application of SVD (Singular Value Decomposition) can be the best among the applied methods for recommendation performance.

Keywords: Intelligent agent and data mining technologies in e-services; product recommendation; content based filtering; singular value decomposition.

I. Introduction

There have been a large number of studies for recommendation of products to promote cross-selling or up-selling in Internet shopping malls. The studies can be broadly classified into two types: collaborative filtering methods that use similarity of ratings for products among shoppers, and content-based filtering methods that utilize features or attributes of products and users [2, 3, 7, 10, 15, 16]. Although collaborative filtering methods have been proved to be successful in many studies, it is often very difficult or expensive to collect the ratings, and moreover, when rating data is sparse, recommendation results are usually impaired severely [9, 14, 18]. For these reasons, because it is easier to collect purchase data and associated product features, content-based filtering methods can be a practically better choice for many real world recommendation problems.

In content-based filtering methods, product attributes and user characteristics, often called features, are collected and analyzed with recommendation models such as statistics methods and artificial intelligence models. The features may comprise of various values such as demographic data or user-specified preferences, but in general, for the practical difficulty of collecting data in Internet shopping malls, many methods suggested in previous studies use characteristics of products that shoppers have purchased or shown interests in the past [13, 17].

Although the product characteristics are comparatively

easier to acquire, there are often too a large number of available features. For example, in the cases of book or movie recommendation, there can be a large number of keyword features of the products from their themes, genres, and text-based description of the products. These features may directly affect the choice of shoppers, and thus, are often used as key features of recommendation, especially for cultural and content-focused products. This problem may lead to inefficiency or ineffectiveness of recommendation. In terms of efficiency, inaccurate or irrelevant keywords may require huge system memory or lead to increased processing time; in terms of effectiveness, there can be often inaccurate or irrelevant words that may damage the recommendation quality. Consequently, it has been recognized to be very important to extract a more meaningful subset of features that can contribute better to recommendation performance [1, 5, 8].

In this study, we utilized a data set that was constructed from a virtual shopping experiment in an Internet book shopping mall in Korea to find out how feature reduction techniques that have been widely used in pattern matching or information retrieval can be applied to the recommendation problem. We used a Korean lexical analyzer to extract features and use the features to construct user and product profiles. The Term Frequency (TF), Inverse Document Frequency (IDF), TFIDF, mutual information, and Singular Value Decomposition (SVD) methods were chosen and adapted for the experiment.

The remaining part of the paper is organized as follows. In the second section, we provide a brief review of feature selection methods from other disciplines. In the third section, we explain the experiment procedure and present the results of the analysis. The fourth section concludes with discussion and further research issues.

II. Review of Related Research

II. 1 Feature Extraction from Product Description

The studies on feature selection has been mainly the focus of pattern matching, machine learning, or text categorization research [1, 5, 8]. The studies have mainly focused on investigating what types of features affect learning performance more. However, there have been not many studies that have applied those methods to product recommendation in Internet shopping malls. Similar methods for feature reduction used for classification problems are often not directly applicable for recommendation.

In order to extract keyword-based features from product

description, the tools and methods developed in the information retrieval field can be well utilized. In general, sentences and phrases of product description include many words that are not suitable to be used as features such as articles, conjunctions, or pronouns. After filtering out unsuitable words, it is needed to extract the stem of the chosen words to make the keywords compatible with other variations of the same stem. For example, after stemming, two words 'processing' and 'processes' will have the same stem 'process'. These processes are usually performed using lexical analyzer software programs, and as the result, vector profiles of features such as $\langle w_1, w_2, w_3, \dots \rangle$ are generated for each product and shopper, where each w_i represents the relative importance of a keyword feature in the profile. Thus, we may compare vectors of users and products to calculate the similarity between them, which can be easily used for recommendation. Two most widely used similarity measures are linear correlation and cosine value between two vectors.

II.2 Vector Space Model

Vector space model[12] is also widely used in the information retrieval field for representing documents and queries. Documents and queries are modeled as vectors of keywords where the keywords have different weights according to their relative importance in documents and queries. Table 1 shows an example vector for a document and a query. If we assume that there are only three keywords such as $\langle \text{information, management, computer} \rangle$, the document and query can be represented with 3 dimensional vectors such as $\langle 0.3, 0.7, 0.1 \rangle$ and $\langle 0.5, 0, 0.8 \rangle$ respectively. Each number in the vectors shows the relative importance of the keywords in the example. We may then calculate the similarity between the two vectors using the cosine measure that will be close to 1 if the two are very similar to each other and 0 if they are very different from each other.

Table 1. Example of vector space representation

Keyword	Document	Query
Information	0.3	0.5
Management	0.7	0
Computer	0.1	0.8

II.3 TFIDF

We have seen examples of weights in the vector representation in table 1. There can be numerous ways of calculating weights but the most widely used weighting scheme in the information retrieval field is TFIDF [12]. TFIDF combines TF (Term Frequency) and IDF (Inverse Document Frequency), where TF is the simple number of occurrence of a keyword in a given document or query, and IDF is the discriminative power of a given keyword in a given set of corpus. For example, a keyword that appears in most documents in a corpus will have a very low value of IDF, while a keyword that appears in only a small number of

documents will have a very high value. As a result, because TFIDF is the product of the two, it considers both the frequency of a keyword within a given document or query and its discriminative power in a given corpus. Formally, TF, IDF, and TFIDF are defined as follows:

$$TF(t, d) = \frac{Occ(t, d)}{MaxOcc(d)} \quad (1)$$

where $Occ(t, d)$ is the number of occurrence of the word t in the document d , and $MaxOcc(d)$ is the number of occurrence of a word that appeared most in d .

$$IDF(t) = \frac{N}{N(t)} \quad (2)$$

where N is the number of entire documents in a given corpus and $N(t)$ is the number of documents that contains the word t .

Accordingly, TFIDF can be calculated as follows:

$$TFIDF(t, d) = \frac{Occ(t, d)}{MaxOcc(d)} \cdot \frac{N}{N(t)} \quad (3)$$

II.4 Mutual Information

Mutual information was first introduced in Shannon's information theory and is used to represent the amount of information that two probability events provide to each other [1, 9]. That is, $MI(a, b)$, mutual information for events a and b , is bigger if the occurrence of an event gives higher information on the occurrence of the other. This value is symmetric for both events, thus, if a and b are more associated probabilistically, they produce higher mutual information value.

In product recommendation, we can use mutual information to estimate how strongly a feature is associated with a user and recommend products with features of higher mutual information value. A mutual information for two events a and b can be calculated as follows:

$$MI(a, b) = \log_2 \frac{P(ab)}{P(a)P(b)} \quad (4)$$

where $P(a)$ is the probability of a 's occurrence, $P(b)$ is the probability of b 's occurrence, and $P(ab)$ is the joint probability of a and b occurring together.

II.5 Singular Value Decomposition (SVD)

SVD is one of the matrix decomposition methods in Linear algebra. The basic idea of this method is based on the fact that a small subset of singular values generated by the decomposition can be a good approximation of the entire original matrix. The decomposition gives us two matrices of orthogonal vectors and a diagonal matrix with singular values as diagonal elements. The number of non-zero diagonal elements equals or is smaller than the dimension of the original matrix. It has been shown that reduced matrices

with smaller dimensions and hence smaller singular values may well produce a matrix which is very close to the original matrix in many research problems. For example, it is often used to compress a large image file or reduce the number of keywords for indexing documents in huge document management systems. In particular, in the information retrieval field, it has been found that the dimension reduction leads to the finding of *latent meaning* in documents, which have been proved to be successful for document indexing and retrieval. The use of SVD in information retrieval is also called Latent Semantic Indexing (LSI) for the reason. The most significant implication of using SVD is that using a smaller dimension in information retrieval may lead to enhanced retrieval performance, contrary to intuition, because SVD helps utilize the latent meaning structure in documents [6, 11].

Figure 1 shows how a matrix can be decomposed using SVD. The original matrix is transformed into a product of the matrices U, D, and V, where U and V are each orthogonal matrices and D is a diagonal matrix where the diagonal elements are called *singular values* of the decomposition. It follows that the singular value σ_i gets smaller as i increases, which means that the earlier singular values have greater influence if we reassemble the original matrix by multiplying the three matrices with only a subset of the singular values.

$$A = UDV^T$$

Figure 1. Illustration of singular vector decomposition

III. Experiment and Analysis

III.1 Data Collection

Data for the experiment and analysis were collected through two activities. First, a virtual shopping experience was performed where 140 examinees browsed freely through a real Internet book shopping mall in Korea and put items they wanted to buy into virtual shopping carts provided by the mall and the result was recorded for each examinee. Table 2 shows the basic statistics of the experiment. Second, they were presented with 32 books as shown in table 3 and were asked to rate the books with scores ranging from 1 to 5, 5 meaning most preferred and 1 meaning least preferred. The 32 books for this experiment were chosen from the 16 categories shown in table 3. We chose only recently published books at the time of the experiment and placed a gap of 1 month between the two experiments to avoid any overlap between the books purchased in the virtual shopping and the 32 books for rating, which was successful. The books collected by the virtual shopping experiment are used

to develop user profiles and the 32 books with ratings are used for evaluating the performance of recommendation using different feature reduction methods.

Table 2. Virtual shopping experiment

Average books purchased	10.93
Standard deviation	7.01
The largest number of books purchased among all the examinees	50
The smallest number of books purchased among all the examinees	2

Table 3. 16 categories from which 32 books were chosen for examinees' rating

Computer/Internet	Management/Economics	Foreign languages	Children
Hobby/health	Comics/Animation	Novel	Poem
Humanity	Essays	Classics	Social science
Science	History	Art	Magazines

Each record collected for the books contains ISBN or ISSN that uniquely identifies a book, as well as title, and description of books.

III.2 Extraction of Features

For the content-based filtering experiments, first, keywords were extracted from the books of the two experiments. Table 4 shows basic statistics of the extracted keywords.

Table 4. Basic statistics of extracted keywords

	Average no. of keywords	Standard deviation	Maximum no. of keywords among all examinees	Minimum no. of keywords among all examinees
Per each user	551.2	238.8	1374	64
Per each of the 32 books for recommendation	150.1	132.5	721	15

Among all the keywords extracted, only 3034 keywords that appear at least once in both experiments were chosen because the other words cannot contribute to recommendation at all. The frequency of keywords shows an exponential distribution as shown in figure 2. This shows that there are keywords that appear too frequently or too rarely, which in both cases may not be effective for recommendation, and which justifies the attempts to reduce the number of keywords.

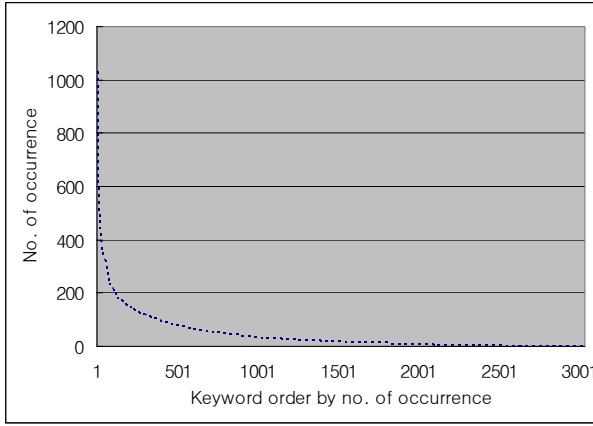


Figure 2. X axis represent each of the 3034 keywords that were ordered by their frequency of appearance. Y axis shows actual frequency of appearance.

On the other hand, figure 3 shows the histogram of keywords according to the frequency of occurrence. This graph roughly shows that a large portion of keywords appear in less than 5 documents and almost all keywords appear in less than 100 documents.

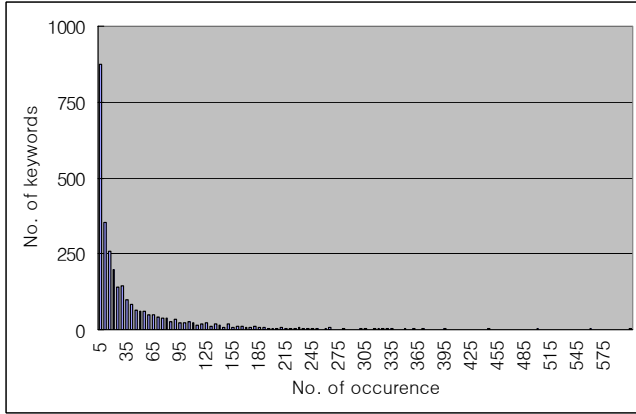


Figure 3. X axis shows the number of occurrences (frequency). Y axis shows the number of keywords for a corresponding frequency on the X axis

III. 3 Recommendation Experiments

With the data collected through the aforementioned methods, 5 recommendation experiments were performed using different ways of feature reduction: TF, IDF, TFIDF, MI (Mutual Information), and SVD. In each of the experiment, we measured the recommendation performance increasing the number of features or dimensions from 1. In using TF, IDF, TFIDF, and MI methods, considering that the average number of keywords in the recommended books is 150, the number of features or keywords was increased up to 200. With the SVD method, since the original matrix is of size 140 by 3034 with only 140 singular values, the experiment was performed using dimensions ranging from 1 to 140. For TF, IDF, TFIDF, and SVD methods, the cosine measure was used for similarity calculation. In the MI method, since we have *information value* for each feature instead of a vector profile, the amount of information measured in bits was used for similarity calculation.

Table 5. Summary of each experiment

Method	Range of features or dimensions	Similarity measure used
TF	1~200	Cosine
IDF	1~200	Cosine
TFIDF	1~200	Cosine
MI	1~200	Amount of information
SVD	1~140	Cosine

(1) Feature reduction using TF

The TF method is the simplest one among the five methods, where we chose those keywords first that appear more in each user profile. We increased the number of keywords for recommendation from 1 to 200.

(2) IDF

With the IDF method, we chose those words first that have higher discriminative power, or higher IDF value. For the calculation of IDF values, we treated all the books purchased by users in the virtual shopping experiment as a corpus.

(3) TFIDF

With this method, the words with higher TFIDF value were chosen first.

(4) MI

Using the MI method, we use the amount of information of each keyword of each user's profile, where the information represents the strength of association between the keyword and the user. For example, if a keyword w is highly associated with a user, the user will purchase many books containing the keyword, and conversely, the books purchased by the user should contain many occurrences of w . Suppose that $P(B)$ represents the portion of the books purchased by a specific user among the entire set of books exposed to the user, and $P(w)$ the portion of books containing the word w , and $P(Bw)$ the probability of the intersection of the two. Then the MI value can be calculated as:

$$MI(B, w) = \log_2 \frac{P(Bw)}{P(B)P(w)} \quad (5)$$

However, we cannot know the size of the entire books exposed, and hence, we cannot precisely measure $P(B)$, $P(w)$, and $P(Bw)$ but should approximate them. First, when the sample size is large enough, we can replace $P(w)$ with $P'(w)$

where $P(w) \approx \frac{N'(w)}{N} = P'(w)$, N is the total number of books found in the virtual shopping experiment, and $N'(w)$ is the number of books that contain w .

Second, suppose $N(U)$ is the number of all the books in

the shopping mall which can be possible exposed to users, and $N(B)$ is the the number of books a user has purchased after being exposed to all the books. Since we may not assume that the user has been exposed to all the books, we use an approximation $N'(B)$ which should be a subset of

$N(B)$: $N'(B) \approx \frac{N(B)}{k}$, where $k > 1$ is an unknown real

number. Upon the same assumption, the size of $N(Bw)$, which is the size of the intersection between B and W , can be approximated in a similar way: $N'(Bw) \approx \frac{N(Bw)}{k}$. Thus,

finally, we can approximate the MI value of a specific keyword for a specific user using only observable values as follows:

$$\begin{aligned} MI(B, w) &= \log_2 \frac{P(Bw)}{P(B)P(w)} \approx \log_2 \frac{\frac{N'(Bw)}{N(U)}}{\frac{N'(B)}{N(U)} \frac{P'(w)}{N(U)}} \quad (6) \\ &= \log_2 \frac{kN'(Bw)}{kN'(B) \frac{N'(w)}{N}} = \log_2 \frac{N \cdot N'(Bw)}{N'(B)N'(w)} \end{aligned}$$

After each MI value for each keyword feature had been calculated, we chose the keywords with higher MI values first for the recommendation test.

(5) SVD

The matrix that utilizes SVD has the size of $\langle \text{No. of keywords} \times \text{no. of examinees} \rangle$. Thus, we have a matrix of size 3034×140 , which was decomposed into U, S, and V as shown in figure 4. Each column vector in the original matrix that corresponds to a single user was composed with TFIDF-based weight values.

$$\begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix} = \begin{bmatrix} u_{11} & u_{12} & \dots & u_{1m} \\ u_{21} & u_{22} & \dots & u_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ u_{m1} & u_{m2} & \dots & u_{mm} \end{bmatrix} \begin{bmatrix} \sigma_1 & 0 & \dots & 0 \\ 0 & \sigma_2 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & \sigma_n \\ 0 & 0 & \dots & 0 \end{bmatrix} \begin{bmatrix} v_{11} & v_{21} & \dots & v_{n1} \\ v_{12} & v_{22} & \dots & v_{n2} \\ \vdots & \vdots & \ddots & \vdots \\ v_{1n} & v_{2n} & \dots & v_{nn} \end{bmatrix}$$

3034 X 140 3034 X m m X m m X 140

Figure 4. SVD decomposition of the user profile matrix (U, S, and V')

Figure 5 shows the 140 singular values that were gained as the result of the decomposition. We can also note that there are a small number of large singular values that may contribute highly to the original matrix.

In order to use the decomposed matrices for recommendation, we apply the following formula to calculate the similarity between user i and a particular book. Assuming that the book is represented as a vector X_q , the following vector is treated as a row of V: $V_q = X_q'US^{-1}$. And then, for the similarity calculation, cosine distance between V_q and V_i for user i is calculated[4].

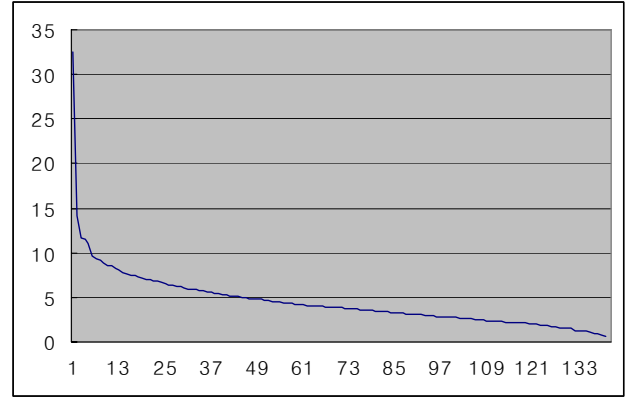


Figure 5. 140 singular values in a descending order

III. 4 Analysis of the Result

Figure 6 shows the result of recommendation experiment with X axis representing the number of features or number of dimensions used for recommendations, and Y axis representing the recommendation performance. In the experiment, 3 books with the highest similarity values were recommended to each user and the average rating of the 3 books by each user was used as a measure of performance.

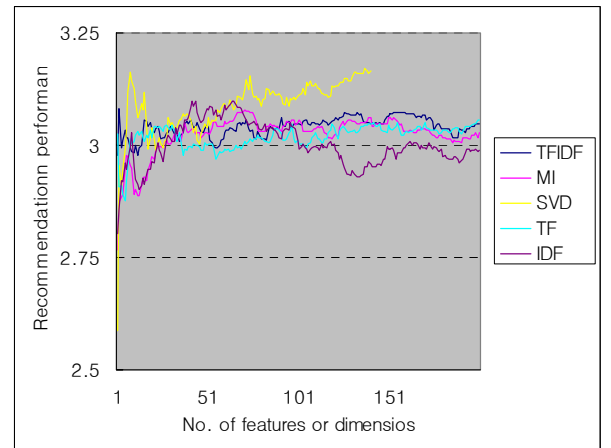


Figure 6. Number of features or dimensions and the recommendation performance

The result in figure 6 can be summarized as follows. First, on the whole, the recommendation using SVD shows better performance than other methods, while there is no different among the performances of the other methods. In TFIDF and TF methods, the results using only a small number of features are not much weaker than the results using much more features. With some variations, it is also observed that the use of additional keywords is not contributing much to increase in the overall recommendation performance. SVD method shows an interesting result where the performance is at its maximum when only 9 dimensions were used for recommendation, while the recommendation performance gradually reaches the same level as the number of dimensions approaches 140. This result is in accordance with the prediction of many studies that have shown that the

dimension reduction of SVD can utilize latent semantics in the data, which may better reflect the nature of data than using the entire set of dimensions.

However, there are a couple of aspects in this result that require more attention. First, although the experiment shows that using SVD may improve the overall recommendation performance, it is not clear how many dimensions should be used in general. For example, in figure 6, when there are approximately 50 features, it is outperforming the SVD method using 50 dimensions. Second, the concept of number of dimension is not exactly the same as the number of features. When using features in other methods than SVD for recommendation, the amount of information the recommendation system should manage is $\langle \text{Number of features} \times \text{Number of users} \rangle$. In the case of SVD, the amount of information required is $\{ \langle \text{Number of features} \times \text{Number of dimension} \rangle + \langle \text{Number of users} \times \text{Number of dimension} \rangle \}$, which is larger than the other methods. This amount is still proportionate to the number of dimensions, and in terms of computational capacity, may not give much burden to recommendation systems. However, when the amount of information is also of great concern, it may be required to consider both aspects when choosing a feature reduction method.

IV. Conclusion and Further Research

In content-based filtering, the number of features has been one of the critical problems in terms of both recommendation efficiency and effectiveness. The contribution of this paper can be summarized as follows. First, we applied feature reduction methods from other disciplines with adaptation to the content-based recommendation problem. Second, we showed that, among the methods, SVD method can present the best recommendation performance with much smaller number of feature dimensions. Further research issues are as follows. First, in the current research, it has not been clearly shown how many features are required in general for various recommendation problems. Second, in order to generalize the findings of this research, experiments using other sets of data from different settings can be required.

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A Global Decision Support System for Garment Manufacturing by Using Genetic Algorithm

Rong-Chang Chen^a, Shiue-Shiun Li^b, Ying-Hua Chen^b, Hsin-Lan Lin^b

^a Department of Logistics Engineering and Management

^b Institute of Business Administration

National Taichung Institute of Technology

No. 129, Sec. 3, Sanmin Rd., Taichung, Taiwan 404

rrchens@ntit.edu.tw, s18931110@ntit.edu.tw

Abstract: In the recent years, each industry has to face the situation of making the decisions from global markets, especially the industries within lower technicality. These industries earn money hardly in the perfectly competitive markets. Sometimes, decision makers have to decide how to allot orders in the different factories because of distinctive requests from individual consumer. It is necessary to find a way to help managers with making a decision and allotting orders effectively.

The purpose of this study tries to develop a decision support system (DSS) to help the managers and decision makers of a real garment industry in Taiwan to decide order allocation, and we used genetic algorithm (GA) for analysis tools and results would be showed by visual graphs to assist managers in decision making. By decision support systems, managers and decision makers might decide order allocation quickly and save the costs.

Finally, the decision support system results in a visional frame within lowest cost, and managers decide order allocation with effectiveness by graphs. With this information, decision makers might make different decisions in unlike situations for dissimilar goals. The system had developed to be used easily and suitable to the garment industries and other similar manufacturing industries.

Keywords: global industry, garment industry, DSS, GA.

I. Introduction

It's very important to make a suitable decision within effectiveness for industries, especially in the global industries. In the past approaches, many scholars and senior decision makers always make decisions by their brains with professional experiences and some information including balance sheets and etc. And they respected to get competitive advantageous positions if decisions could fulfill demands of consumers [1-4]. By this traditional method to make decisions has become more difficult and inefficient in recent years because sciences and information technology grow up fast causing influencing factors excess and complex. Many enterprises have to make efforts on the global logistics management (GLM) for raising their competitive capability, but there are still some problems to be solved.

In generally, benefits of consumers from a competitive market are limited. It is harder to obtain extra profits than to reduce costs. The proprietors of global industries always try to find a way to reduce cost without high interests. Some scholars proposed that using resources around the whole world properly could decrease costs [5]. Taking the garment industry in Taiwan for example, it has lower entry barriers and a new competition enters easily with advanced technology so if the global garment industry want to move manufacturing factories from Taiwan to other countries, it is easier than other industries. To find cheaper labors is necessary for garment industry. This is why many global industry move factories to developing country to get some resources [6].



Fig. 1 The global sketch of a real famous garment corporation in Taiwan

As Figure 1 shows, country of origin, main markets, and manufacturing factories are in the different geographical locations, even in the different countries. The data presented in Figure 1 was collected from a real global garment corporation in Taiwan and triangles represent sales offices, the rhombuses represent factories producing fabrics, the circles represent for factories producing garments, and the squares stand for places of providing raw material for garment.

Global resources bring the chance to reduce costs and cause some problems. To transport goods by freighters often takes long time. In global competitive markets, the most

important job is to satisfy with customers including productions and delivery date. Reducing delivery time and quickly responses would let industry get lower costs [7]. Thus, many decision makers always try to make a decision for allotting orders with effect to different manufacturing factories, and the decision must conform to minimum cost. In traditional method, making a decision for order allocations wastes time and often be impacted by decision makers' and managers' personal experiences. There are lots of influencing factors affecting a decision making. If decision makers made a wrong choice, the final result causes additional costs. "Decision Support System, DSS" was developed for assisting decision makers and senior managers to make a correct decision for corporation goals, and it also solve the problems with uncertain and blurred elements [8]. With electronic technology, DSS could process complex and a great quality of factors. Thus, DSS [9, 10] would be a important role in the modern garment industry.

In this study, we tried to develop a global decision support system for a real garment corporation in Taiwan. The senior managers in the corporation try many ways to conduct electronic systems into business strategies, especially in decision making. They respect that could get a helper to make a decision within the goal of lowest cost. Because of lowest cost, we let "Genetic Algorithm, GA" [11-19] be a analytic tool for the decision support system. After executing the system, the results would be presented by Gantt charts and lists, and decision makers and managers could make decisions effectively by charts and lists.

The rest of this paper is introduced as follows. Section 2 depicts slightly overviews of "Genetic Algorithm" and "Decision Support System". The approach of this study is described in Section 3. Section 4 would describe the experimental results. Finally, conclusions are presented by summarizing the findings in Sections 5.

II. Genetic Algorithm (GA) and Decision Support System (DSS)

II.1 Genetic Algorithm (GA)

Genetic Algorithm (GA) was developed by Holland. GA is usually used to find the best solution or process complex problems by the different ways with the rules as imitating organisms' evolution. It is just like a learning cycle and it is always executing until satisfying the goals of decision makers need. After each round of checking results, the better result would replace the bad one within conditions made by senior managers. The processing of GA is presented as Figure 2 shows as following.

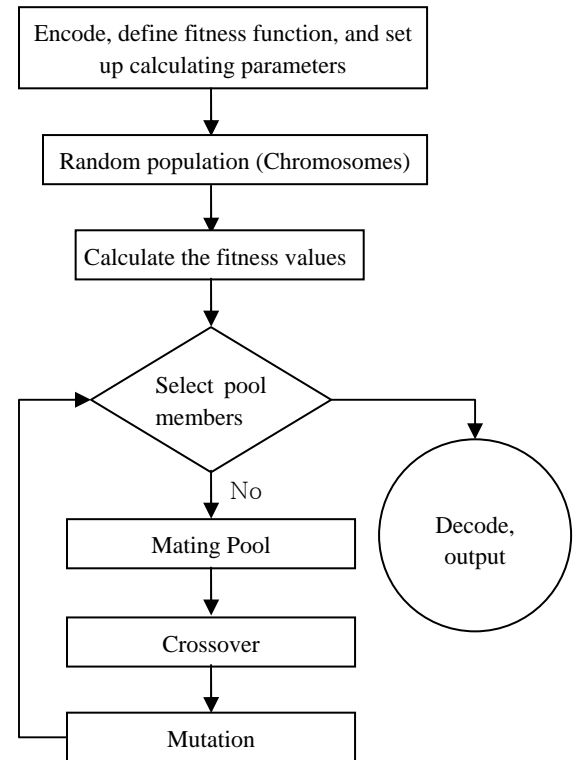


Fig. 2 The flowchart of GA

GA has applied to lots of fields, such as system intrusion detection [20], production scheduling [21], and others [22]. Maybe the subjects are different, but it confirmed GA could process complex data.

The characteristics of GA different from traditional algorithms were defined as following [23].

- 1) GA is more suitable for solving some complex problems because it uses encoding string to calculate, and it won't be limited by some real condition of parameters.
- 2) GA is a better tool to find a global optimization than other algorithms because GA is used to calculate from many of points to find the best solution.
- 3) While calculating, it is necessary to add some extra numeric to find the best solution. The final result is impacted easily by additional values. GA calculates with information created by previous generations.
- 4) GA suits different kinds of problems because it randomizes chromosomes for copulations and mutations.

In some studies, GA could execute varied phenotypes in multi-processing units so it would handle a large number of data [24].

II.2 Decision Support System (DSS)

The concept of DSS was presented by Scott Morton [25] and the system was called "Management Decision Systems". The main characteristic of systems is to assist decision makers to use data and models to solve unstructured

problems by interactive decision systems. As figure 3 shows, there are three principal elements within DSS, including Data base Management Software (DBMS), Model Base Management Software (MBMS), and Dialog Generation and Management Software (DGMS) [8].

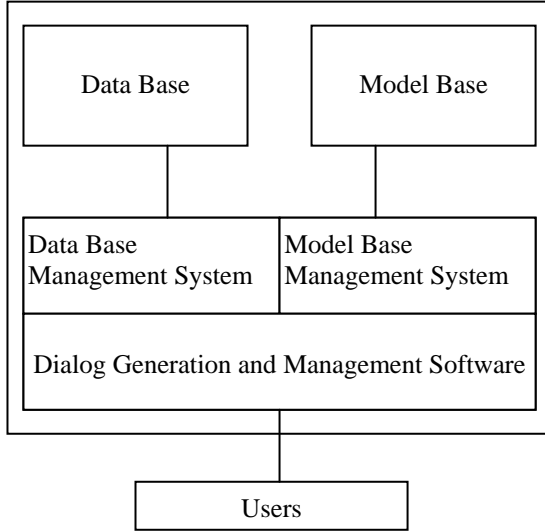


Fig. 3 The structure of GA [8]

The purpose of DSS is not to do decisions for senior managers or decision makers. It always creates some information by tables and lists to assist senior managers to make a correct decision. It also helps decision makers to settle the semi-structured and unstructured problems [26, 27]. DSS can calculate by different formulas and fit it to the real situations with electronic systems because the conditions of global industries always change.

III. Approach

III.1 Influencing Factors of the Decision

There are about some important influencing of a order allocation decision, including competitive strategies of business, global competitive environments, tariff duties and quotas, elements of consumers, elements of politics from each country, capacity, delivery time, costs, technology of manufacturing factories, and elements of factories' operations.

Each kind of industry has own goal of strategy, for example lowest cost, and the goal also impacts the final decision. The final decision would influence some decisions of partners from supply chain. Quotas could impact deeply on global garment industry from each country, especially in Taiwan. Since 2005, World Trade Organization (WTO) had announced canceling quotas measure of the whole world. The policy has exchanged import and export of garment industry.

In global garment industry, to satisfy demands of consumers and deliver goods on time are two major factors to enhance competitive capabilities. If senior managers wants to get lowest, there are some factors had to be solved, including order allocation. To shorten delivery time could

reduce correlative costs.

III.2 The Structure of DSS

After interviewing with senior managers from a real global garment corporation, we synthesize the documents and factors provided by managers. We built a model with these factors and the model is presented as figure 4 as following.

As we have said above, there are many complex elements that could influence our decisions and every element also could influence one another. Therefore, we select the strategies by gradation.

In the first stage, this is a very broad field of making decisions. This stage is aimed at the goals of the organization and competitive strategies. Senior managers have to consider more and extensive factors such as the competitive strategy of the organization, global competition and internal constraints and select the supply chain strategy. In this stage, it pertains to long-term decisions. On the contrary, as short-term decisions, we regard as static.

There are different features and technology such as factors of customers between each factory. In the second stage, we consider some factors including production technology, factors of customers, quote and rewards, and regional demand to weed unsuitable factories artificially. Through the influence of these factors, we select some suitable factories. In this way, we could reduce complication of computation.

After second stage, we select parts of the factories because of some factors, but it may lead to the high cost. In the third stage, we balanced the capacity. Therefore, we select the factories with capacity surplus and less utilization ratio to balance the capacity and find the suitable factories effectively.

In the fourth stage, we take cost minimum as the goal to select the most applicable factory. Therefore, we draw on systematized tools like Gantt chart to simulate the strategies and find the most applicable factory. Also, it assists senior managers or decision makers in making decisions.

In line with the rules of how an organization works and consulting some excellent documents, we come up as figure 4 showing.

III.3 Encoding and Calculating

Before beginning to calculate by using GA, we have to define and encode some elements. In this study, each order was presented by each gene and denoted the number for each order as A, B, C, and etc. The fitness function combined by "Cost Based Measure, CBM" and "Due-date Related Measure, DRM" can be presented as

$$F = \sum_{i=1}^n [w_1 CBM(i) + w_2 DRM(i)] \quad (1)$$

and w_1 is the weight of CBM and w_2 is the weight of DRM.

Both of w_1 and w_2 are binary.

$$CBM(i) = M_i + T_i + L_i \quad (2)$$

where

M_i is the raw material cost of i_{th} order.

T_i is the transportation cost of i_{th} order.

L_i is the labor cost of i_{th} order.

If the goods deliver late, the additional cost can be expressed as

$$DRM(i) = \max[(C_i - D_i), 0] * Q_i * U_i * \mu \quad (3)$$

where

C_i is finish time of i_{th} order.

D_i is expected delivery date of i_{th} order.

Q_i is the amount of garments of i_{th} order.

U_i is the price of each garment of i_{th} order.

μ is the punitive factor behind time.

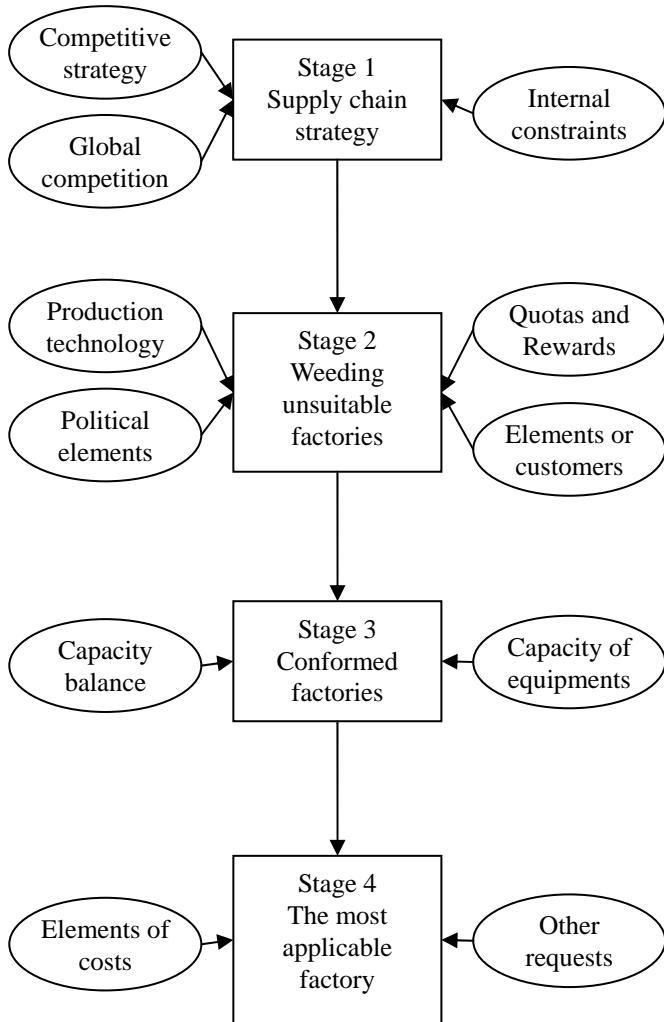


Fig. 4 The processing of DSS

IV. Experimental Result

In this study, we used Microsoft Visual C++ to develop the global decision support system and the operation system was Windows XP. We used GA to be a analytic tool, population size was 100, crossover rate was 0.8, mutation rate was 0.05, and generation was 100. Because of complex types of real data, we wanted to present the status of data as true as possible, and then, we encoded in enumerating was employed rather than in binary. We used two-point crossover and two-point mutation to find the final solution.

The system always executes based on “lowest cost” and it also provides two goals for decision makers, including “the highest capacity utilization rate” and “the highest on-time delivery rate. If a factory can not fulfill with requirements of orders, there is a red vertical line shown up and warn the decision makers.



Fig. 5 The initial frame of global garment DSS

This system provides “semi-manual” and “semi-automatic” methods to executive for decision makers. As figure 6 shows, if there are some orders important, decision makers could put them into the schedule. After scheduling by decision makers, the system would arrange remainder orders. The red line in left of figure 5 means the final time when fulfilling contracts, and the green line means time to start manufacturing.

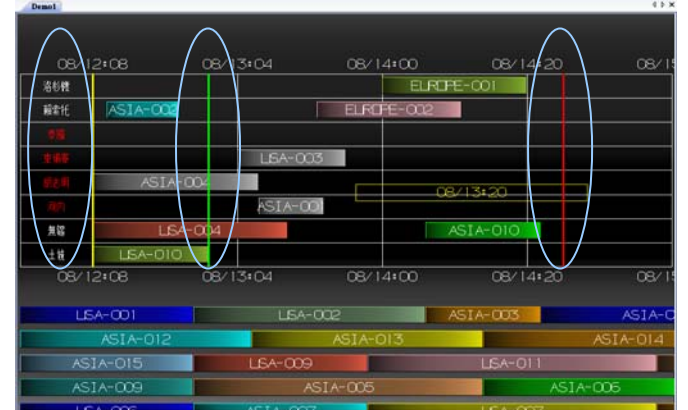
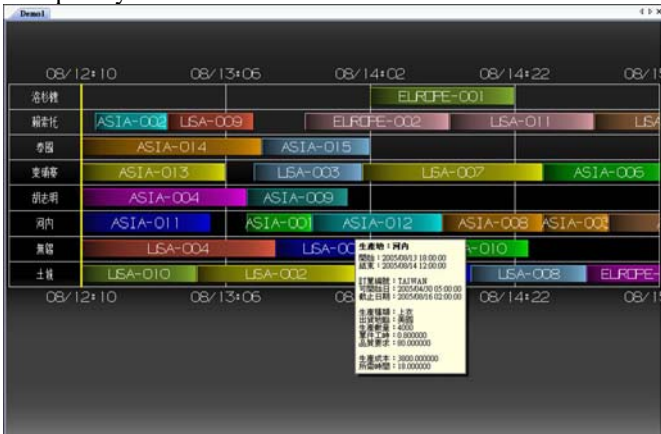


Fig. 6 Scheduling by semi-automatic

	08/12+10	08/13+06	08/14+02	08/14+22	08/15+00
宮村睦			EUROPE-001		
梶山光	ASIA-002	LSA-009	EUROPE-002	LSA-011	LSA-012
夢園	ASIA-014	ASIA-015			
史緒華	ASIA-013	LSA-003	LSA-007	ASIA-006	
胡志明	ASIA-004	ASIA-009			
周內	ASIA-011	ASIA-001	ASIA-012	ASIA-008	ASIA-001
羅露	LSA-004	LSA-001	ASIA-010		
士雄	LSA-010	LSA-002	LSA-005	LSA-008	EUROPE-003

When users had decided some important orders, they could arrange surplus orders into fit factories automatically. As figure 7 shows, users could press “Agent” and the system would schedule the orders. This system also provides a function that when users press the right button on the mouse, we can check information of data including costs, numbers of orders, kinds of goods, information of consumers, and etc. As figure 8 shows, information would present as a list. Decision makers or senior managers could compare information and make a manufacturing decision correctly and quickly.



V. Conclusion

The global DSS contains three major elements, including input databases and parameters, the analytical tools, and the presentation mechanism. The input data was collected by Enterprise Resource Planning (ERP) systems of a real garment corporation. Because there are too many factors with making a decision, we used genetic algorithms (GA) to be a analytical tool. GA is a useful tool to solve the problems within complex factors.

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Rough Set Approaches to the Problem of Supplier Selection

Shi-jing Wang¹, Hua-an Hu²

Procurement Department, Wuhan Institute of Economics, Luojiadun 122,
Wuhan, 430035, China

¹E-Mail: wsj_1979@yahoo.com.cn; Tel. 86-013971071036

²E-Mail: huhuaan@hotmail.com; Tel. 86-02783447650

Abstract: The data mining approach of rough set theory is being adopted to study the multi-index question of supplier's evaluation and determination in order to reveal the determining rules hidden in the historical evaluative data. After introducing some basic notions of rough set theory, this paper uses a sample to tell the steps of the deducing process in detail, and figures out some satisfying rules of supplier's determination and weights of various attribute's indexes which have been compared to other methods after the calculation. All of these illustrate the method of rough set theory can be used in the area of supplier's selection and solve them with great efficiency.

Keywords: Decision Support, Group Systems

I. Introduction

The supplier's determination is the core of the whole acquisition system, and it can be considered as the most important step in the acquisition process. It has been a time-consuming question for each administrative sector to determine an appropriate supplier. Nowadays, various approaches are adopted to solve the problem of suppliers determination and decide on the quantity of the stocking goods from a selected supplier. The common methods include description, experience and optimization method etc. The descriptive and experimental methods describe the feature of the supplier or set up the weights of determination indexes to undertake the evaluation, the typical methodologies are the plus-weight element analysis method, layer-analysis method and so on[1][2]. As the weights of the determination indexes are set up on the basis of the determiner's experience, the evaluative result is somewhat subjective unavoidably. The optimization method is used to determine who is the supplier of paying the less, and suiting to the special requirement on the basis of the product quality and the consignment of time. Eventually, the factors such as linear, non-linear design, dynamic planning and objective planning are often involved, so the evaluative process is much more complicated. Further more, the determinative process may not be continuous and complete because the historical evaluative data of suppliers are not covered in the method. Rough set theory is a mathematic tool to deal with the incomplete and uncertain problems, to analyze and

dispose efficiently the imperfect information, to uncover the hidden knowledge and reveal its potential rule based on the people's cognition of acquired data[3].

The rest of this paper is organized as follows. Section 2 briefly describes the basic notions of rough set theory. Section 3 provides a case on suppliers' determination and tells the applications that rough set theory can be used in such problems. Concluding remarks and directions for further research are given in section 4.

II. Basic Notions Of Rough Set

II.1. Positive, Negative And Boundary Region

Let U be a non-empty finite set, called universe, and R be an equivalence relation. The pair $K = (U, R)$ is referred to as knowledge base and conceptually, represents our knowledge about the universe. The equivalence relation represents a classification of the domain objects into disjoint classes of objects, which are indistinguishable in terms of available information about them. In other words, these classes represent the basic properties of the universe that can be expressed by the knowledge represented by the relation R , and so they are referred to as elementary categories.

Any subset $X \subseteq U$ of the universe will be called a concept in U . Some concepts can be exactly defined in the approximation space K , whereas other ones cannot be defined. A subset X is an exact set or definable in K , if X is the union of some elementary categories, otherwise, X is a rough set or un-definable. A rough set can be defined approximately by the employment of two exact sets, called lower and upper approximations. The lower approximation, denoted as $R_-(X)$, is the set of all elements of domain objects U , which can be certainty classified as elements of a concept X in the knowledge R . The upper approximation, denoted as $R(X)$, is the set of elements of U that can be possibly classified as elements of X using knowledge R . According to these basic concepts, universe can be divided into three disjoint regions, called positive, negative and boundary regions and defined as follows:

$$POS_R(X) = R_-(X) \quad (1)$$

$$NEG_R(X) = U - R(X) \quad (2)$$

$$BND_R(X) = R(X) - R_-(X) \quad (3)$$

The positive region $POS_R(X)$ has the same interpretation as lower approximation. The negative region $NEG_R(X)$ is the collection of objects that can be determined without ambiguity, employing knowledge R , that they do not belong to the set X , that is, they belong to the complement of X . The boundary region $BND_R(X)$ is the un-decidable area of universe, i.e. none of the objects belonging to the borderline area can be classified with certainty into a set X or its complement ($-X$), at least using knowledge R .

II.2. Reduction, Core And Attribute's Significance

The rough set framework is especially suitable to the determination of attribute-value relationships in attribute-value systems. Information systems are formal models of attribute-value systems[4].

Rough set is defined as an information system as a pair $S=(U,A)$, where U is a non-empty, finite set called the universe, and A is a none-empty, finite set of attributes. Also we can describe S in detail that it contains four subsets, $S=\{U, A, V, f\}$, A contains two subsets C and D , that's mean $A=C \cup D$, where D is a distinguished attribute called the decision attribute, elements of set C , are referred to as condition attributes. V is the set of values of A , called the domain of A , and f is the function that can be defined as: $\forall a \in A, x \in U, f(x, a) \in V$. We can call such information system a decision table, it represents a classification of the domain of interest. The decision attribute establishes a partition of the universe in disjoint classes. We are interested in identifying every class according to values of condition attributes.

An equivalence relation, called indiscernibility relation, is associated with every subset of attributes $B \subseteq A$. This relation is defined as:

$$IND(B) = \{(x, y) \in U \times U : \forall a \in B, a(x) = a(y)\} \quad (4)$$

During the application of rough set theory, we must emphasize two definitions: Reduction and Core. Reduction means deleting the redundant attributes and values of the decision table. In order to reduce the complexity and gain a better result, a parallel arithmetic should be used. So the definition of core is being put forward. Core consists of indispensability attributes, and it can be deduced by the significance of attributes. Suppose r is a equivalence relation of R, G and R are two sets, if $POS(R - \{r\})(G) = POSR(G)$, then we say r can be reduced, or can not be reduced. If any element of R can not be reduced, then we call R is independent. Suppose $H \subseteq R$ and H is an independent set, if $POSH(G) = POSR(G)$, then H is the G reduction of R . The intersection of all relations that can not be eliminated in set R call the core of R , noted $Core(R)$.

Suppose C, D are subsets of A , then the dependency of knowledge D to Knowledge C can be described as: $\tau = \gamma(C, D) = Card(PosCD) / Card(U)$. $Card$ is the radix of set A , and $PosCD$ is the positive region of knowledge D to C . At the foundation of dependence, the significance of an attribute can be described as the changes happening to the

classification of the set after the attribute eliminated from the condition attributes. i.e.

$$Sig(C_i) = \frac{\gamma(C, D) - \gamma(C - \{C_i\}, D)}{\gamma(C, D)} \quad (5)$$

In formula 5, i is the number of condition attribute, the significance of an attribute describes the effect which takes in the whole decision table and influences to the decision result.

In the rough set framework, the simplifying process of a decision table includes two fundamental tasks. On the one hand, reduction of attributes consists of eliminating redundant or irrelevant attributes, without losing any essential classification information. On the other hand, reduction of attribute values is related to the elimination of the maximum number of condition attribute values, maintaining the classificatory power. Thus, if we obtain a reduced table, it is known as the decision algorithm. Each row of the table represents a decision rule.

Perceived value is a difficult concept in that it is hard to define and measure (Zeithaml, 1988; McDougall and Levesque, 2000). Broadly defined, perceived value is the results or benefits customers receive in relation to the total costs. In other words, it is the difference between perceived benefits and costs (McDougall and Levesque, 2000).

According to Zeithaml (1988), customer-perceived value is the consumer's overall assessment of the utility of a product based on a perception of what is received and what is given. This can vary between people but also from occasion to occasion for the same person (Zeithaml, 1988). Caruana et al. (2000) state; "value is seen to be more individualistic and personal than quality and involves both a give and get component" (p. 1339). Raval and Grönroos (1996) suggest that customer-perceived value has to be related to different personal values, needs and preferences. In addition, they state, that the financial resources of the consumer must be taken into account.

III. A Case On Supplier's Determination

III.1. Initial Data of Suppliers

This section demonstrates the application of rough set theory on supplier's determination through a case. The integrated indexes of evaluating suppliers during the actual procurement activities are: Product Quality(PQ)、Purchase Cost(PC)、Service Quality(SQ)、Fulfillment Of Contract(FOC) etc[5]. Before the step of knowledge discovering through rough set theory from the suppliers' history operation data, we must organize the data in a proper order.

Suppose we have the history data table (Table1) of ten suppliers, in order to reduce the complexity of our exemplification in the case, we classify the four indexes that influence the determination of suppliers into two conditions:

Table1. Suppliers' History Date Table

NO	PQ	PC	SQ	FOC	SL
1	Good	High	Good	Bad	Medium
2	Good	Low	Good	Bad	Important
3	Bad	Low	Bad	Bad	Subordinate
4	Bad	High	Good	Bad	Subordinate
5	Bad	Low	Good	Bad	Medium
6	Good	Low	Good	Good	Important
7	Good	Low	Bad	Good	Important
8	Good	High	Bad	Bad	Subordinate
9	Good	High	Good	Good	Subordinate
10	Bad	Low	Good	Good	Medium

Table2. Suppliers' History Date Table after Dispersing

NO	a	b	c	d	e
1	1	0	1	0	1
2	1	1	1	0	2
3	0	1	0	0	0
4	0	0	1	0	0
5	0	1	1	0	1
6	1	1	1	1	2
7	1	1	0	1	2
8	1	0	0	0	0
9	0	0	1	1	0
10	0	1	1	1	1

Good、Bad or High、Low and Suppliers Level(SL) into: important 、medium and subordinate. Universe $U=\{1,2,3,4,5,6,7,8,9,10\}$, Condition attribute set $C=\{\text{Product Quality, Purchase Cost, Service Quality, Fulfillment Of Contract}\}=\{PQ, PC, SQ, FOC\}$, Decision attribute set $D=\{\text{Suppliers Level}\}=\{SL\}$.

Here, we use number 1 represents Good condition or low cost, while 0 represents Bad condition or high cost in the value of condition attributes. In decision attributes value, 2 represents the supplier is Important、1 represents Medium and 0 represents Subordinate. After dispersing the data, we use a、b、c and d representing the condition attribute PQ, PC, SQ and FOC, while e representing the decision attribute SL. After these works, we get Table2.

III.2. Application on Rules mining

Form Table1, we know that each row represents a supplier while a column represents an evaluating index to the supplier. These indexes are called attributes in the table and classified into condition attributes and decision attributes. In order to form the simplest decision one, we can reduce the table through the reduction theory of rough set. Then, the decision rules about the selection of suppliers can be deduced from the simplest table. All the rules can guide

the decision makers to choose a good supplier from competition ones.

The detailed steps of mining rules are as followings:

(1)Describe the attribute values of history data in a standard mode and reduce the redundant attributes.

(2)Make reduction to the value of decision rule and make out the core of each rule.

(3)Select the effective decision rule to form the reduced decision table.

Now, we use the method of attribute's significance to reduce the redundant attributes of condition table in step(1) above.

$$U/\text{Ind}(a)=\{(1,2,6,7,8)(3,4,5,9,10)\},$$

$$U/\text{Ind}(b)=\{(1,4,8,9)(2,3,5,6,7,10)\},$$

$$U/\text{Ind}(c)=\{(1,2,4,5,6,9,10)(3,7,8)\},$$

$$U/\text{Ind}(d)=\{(1,2,3,4,5,8)(6,7,9,10)\},$$

$$U/\text{Ind}(a,b,c,d)=\{(1)(2)(3)(4)(5)(6)(7)(8)(9)(10)\},$$

$$U/\text{Ind}(e)=\{(1,5,10)(2,6,7)(3,4,8,9)\},$$

$$\text{PosC}(D)=\{1,2,3,4,5,6,7,8,9,10\},$$

$$\gamma C(D)=|\text{PosC}(D)|/|U|=10/10=1.$$

After reducing attribute a:

$$U/\text{Ind}(b,c,d)=\{(1)(2,6)(3)(4,9)(5,10)(7)(8)\},$$

$$\text{PosC}-(a)(D)=\{3,7,8,9\},$$

This time, the dependence of attribute a is:

$$\gamma C-(a)(D)=4/10=0.4.$$

Following the same principle above, the dependence of other attributes are:

$$\gamma_{C-(b)}(D) = 4/10 = 0.4,$$

$$\gamma_{C-(c)}(D) = 6/10 = 0.6,$$

$$\gamma_{C-(d)}(D) = 10/10 = 1.$$

From the attributes' dependence we know that the classification ability does not change after deleting attribute d, so attribute d is redundant in this decision table. Then deleting attribute d and unite line 1 and 2, line 3 and 8, 7 and 10, we get a new decision table Table3.

Table3. Decision Table after Attribute Redundant

NO	a	b	c	e
1	1	0	1	1
2,6	1	1	1	2
3	0	1	0	0
4,9	0	0	1	0
5,10	0	1	1	1
7	1	1	0	2
8	1	0	0	0

The second step of the deduce process is value reduction to table 3 and achievement of the cores of all rules. First, let us look at rule 1 of Tab.3:

$$\text{Set } F = \{[1]a, [1]b, [1]c\}$$

$$= \{(1,2,6,7,8), (1,4,8,9), (1,2,4,5,6,9,10)\}.$$

$$\text{Decision Category } [1]e = \{1,5,10\}.$$

$$\text{Here, } a(1)=1, b(1)=0, c(1)=1, e(1)=1.$$

$$[1]a \cap [1]b = \{1,8\}, \{1,8\} \not\subset [1]e;$$

$$[1]a \cap [1]c = \{1,2,6\}, \{1,2,6\} \not\subset [1]e;$$

$$[1]b \cap [1]c = \{1,4,9\}, \{1,4,9\} \not\subset [1]e.$$

So, we make out the core of decision rule 1, the core is: $a(1)=1, b(1)=0, c(1)=1$.

In the same method, we can get the cores of other decision rules:

$$\text{Core of rule 2 and 6 is: } a(2)=1, b(2)=1;$$

$$\text{Core of rule 3 is: } a(3)=0, c(3)=0;$$

$$\text{Core of rule 4 and 9 is: } b(4)=0, c(4)=1;$$

$$\text{Core of rule 5 and 10 is: } a(5)=0, b(5)=1, c(5)=1;$$

$$\text{Core of rule 7 is: } a(7)=1, b(7)=1;$$

$$\text{Core of rule 8 is: } b(8)=0, c(8)=0.$$

At last, we get the decision Table4 after the value reduction.

Table4. Decision Table after Value Reduction

NO	a	b	c	e
1	1	0	1	1
2,6	1	1	—	2
3	0	—	0	0
4,9	—	0	1	0
5,10	0	1	1	1
7	1	1	—	2
8	—	0	0	0

At last, we get the rules about suppliers' determination from Table4, these are:

(1) If supplier's product quality and service quality are good, though the cost of purchase is high, we can consider the supplier as a medium one during selection;

(2) If supplier's product quality is good and the cost is low, even we don't know the other indexes of the supplier, we can consider it as an important one;

(3) If the supplier's quality of product and service are bad, even we don't know the other indexes of the supplier, we can consider it as a subordinate one;

(4) Need not consider supplier's product quality, if the cost is high, though the service quality is good, we also consider it as a subordinate one;

(5) If the supplier's product quality is bad, while the cost and service are satisfying, we can consider it as a medium one during selection;

(6) Need not consider supplier's product quality, if the cost and service are not satisfying, then we can consider it as a subordinate one.

III.3. Application on Weights Ascertainning

Besides the rules we got in section 3.2, we can also make out the weights of the evaluating indexes of these suppliers from the following steps.

(1) According to formula (5), make out all the significances $\text{Sig}(C_i)$ ($i=1, 2, \dots, n$) of every attributes in set $C=\{C_1, C_2, \dots, C_n\}$.

(2) Treat $\text{Sig}(C_i)$ we got in step(1) with formula (6) and consider the result P_i as the objective weight of every condition attribute C_i .

$$P_i = \text{Sig}(C_i) / \sum_{i=1}^n \text{Sig}(C_i) \quad (6)$$

(3) Experts give the subjective weights $Q_i (i=1, 2, \dots, n)$ of all attributes of set $C=\{C_1, C_2, \dots, C_n\}$ and the subjective

weights must fulfill the condition of $\sum_{i=1}^n Q_i = 1$.

(4) Decision makers choose the proper experiential factor “ α ” and make out the integrated weights of attributes C_i based on formula (7).

$$I = \alpha Q + (1 - \alpha)P \quad (0 \leq \alpha \leq 1) \quad (7)$$

The first step is to make out the significances of all attributes, so the significances of suppliers' evaluating indexes a 、 b 、 c and d are:

$$\text{Sig}(a) = (\text{PosC}(D) - \text{PosC}(a)(D)) / \text{PosC}(D)$$

$$= (1 - 0.4) / 1 = 0.6,$$

$$\text{Sig}(b) = (\text{PosC}(D) - \text{PosC}(b)(D)) / \text{PosC}(D)$$

$$= (1 - 0.4) / 1 = 0.6,$$

$$\text{Sig}(c) = (\text{PosC}(D) - \text{PosC}(c)(D)) / \text{PosC}(D)$$

$$= (1 - 0.6) / 1 = 0.4,$$

$$\text{Sig}(d) = (\text{PosC}(D) - \text{PosC}(d)(D)) / \text{PosC}(D)$$

$$= (1 - 1) / 1 = 0.$$

According to formula (6), we can get:

$$\text{Sig}(a)' = 0.6 / (0.6 + 0.6 + 0.4 + 0) = 0.375,$$

$$\text{Sig}(b)' = 0.6 / (0.6 + 0.6 + 0.4 + 0) = 0.375,$$

$$\text{Sig}(c)' = 0.4 / (0.6 + 0.6 + 0.4 + 0) = 0.25,$$

$$\text{Sig}(d)' = 0 / (0.6 + 0.6 + 0.4 + 0) = 0.$$

After getting the objective weights P_i , we should combine them with experiential ones Q_i . Here, suppose experts' weights of condition attributes $C=\{a, b, c, d\}$ are 0.3、0.4、0.2 and 0.1, decision makers attach much more importance to experts knowledge, so we choose the experiential factor to 0.8, then, according to formula (7), these integrated weights are:

$$I(a) = 0.8 \times 0.3 + (1 - 0.8) \times 0.375 = 0.315,$$

$$I(b) = 0.8 \times 0.4 + (1 - 0.8) \times 0.375 = 0.395,$$

$$I(c) = 0.8 \times 0.2 + (1 - 0.8) \times 0.25 = 0.21,$$

$$I(d) = 0.8 \times 0.1 + (1 - 0.8) \times 0 = 0.08.$$

From the Formulas above we know that the weights of ascertaining indexes a 、 b 、 c 、 d are: 0.315、0.395、0.21、0.08. So, decision makers emphasize “Cost” most during their procurement, the followings are “Product Quality”、 “Service Quality” and “Fulfillment Of Contract”.

Table5. Attributes' weights from different methods

Meth \ Attrib	a	b	c	d
Delphi	0.300	0.400	0.200	0.100
Statistic	0.375	0.375	0.250	0
Duality comparison	0.333	0.333	0.250	0.084
Rough Set	0.315	0.395	0.210	0.080

Table5 compares weights of attributes deduced from different methods. Comparing with other methods (Delphi or Statistic Method), we can see that the weights deduced from method rough set are much more accorded with the principle of ascertaining weights (the principle of combining subjective attitudes of decision makers with objective condition). This method considers both the suggestions of experts and the influences of objective statistics, avoiding the shortcoming of emphasizing particularly on one side in ancient methods. Decision makers can choose proper experiential factor to modify the proportion of subjective and subjective significances according to the background of application, this way, we can get more rational indexes' weights of evaluating suppliers.

IV. Conclusions

From the case have presented above, we can draw the conclusions about the application of rough set theory on the selection of suppliers as follows:

(1) From the sight of objectivity of supplier's determination, the application of rough set, can make out the weights of decision indexes objectively and reflect the weights of them, avoiding the condition of establishing the weights subjectively in other evaluating approaches. Further more, with the increase of experiment data, the rules we deduce will press close to the real world, so the approach of rough set can increase the objectivity and reality of the determination.

(2) From the sight of continuity of supplier's determination, the application of rough set, can take good advantage of the supplier's history evaluating data and analyze the experimental knowledge of former determination, finding the potential rules in supplier's selection. So, the classification model established through rough set has good continuity.

(3) From the sight of data mining, the decision table in rough set approach is similar with the relation table in relation database, so the application of rough set is good at practicability and reliability[6]. In addition, rough set

approach can analyze suppliers' historical data in advance and delete the redundant attributes, so it improves the efficiency of determination and reduces the faulty rate.

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An Approach to Integrate Heterogeneous Data Sources

Chaiyaporn Chirathamjaree

School of Computer and Information Science, Edith Cowan University, Perth, 6050, Australia
c.chirathamjaree@ecu.edu.au

Abstract: To gain a competitive advantage, it is extremely important for executives to be able to obtain one unique view of information, normally scattered across disparate data sources, in an accurate and timely manner. To interoperate data sources which differ structurally and semantically, particular problems occur, for example, problems of changing schema in data sources will affect the integrated schema. In this paper, conflicts between heterogeneous systems are investigated and existing approaches to integration are reviewed. This research introduces a new mediated approach employing the Mediated Data Integration Mediator (MeD-Int), and wrapping techniques as the main components for the integration of databases and legacy systems. The MeDInt mediator acts as an intermediate medium transforming queries to subqueries, integrating result data and resolving conflicts. Wrappers then transform sub-queries to specific local queries so that each local system is able to understand the queries. This framework is currently being developed to make the integration process more widely accessible by using standard tools. A prototype is implemented to demonstrate the model.

Keywords: Decision Support & Group Systems Conflict Resolution, Heterogeneous Databases, Integration, Legacy Systems, Mediation, Wrappers.

I. Introduction

The information required for decision making by executives in organizations is normally scattered across disparate data sources including databases and legacy systems. To gain a competitive advantage, it is extremely important for executives to be able to obtain one unique view of information in an accurate and timely manner. To do this, it is necessary to interoperate multiple data sources, which differ structurally and semantically. In the process of interoperating any two or more database systems, there are critical problems that need to be solved, for instance, some databases are designed from different models, objects which have the same meaning in different databases might have different names, and objects which have the same meaning in different systems might be measured by different units. Furthermore, there are identity conflicts, representation conflicts, scope conflicts, etc [1; 2; 4; 8; 9]. Although several researchers have studied the conflicts and integration of heterogeneous database systems [1; 9; 11; 13; 14; 17], there is still no common methodology for resolving conflicts and integrating such databases. Particularly, few studies have

focused on the integration of databases and legacy systems. In legacy systems, the semantics are hidden and hard to determine. In fact, some legacy systems store data to flat files, which are completely different in schematic design from database management systems (DBMSs).

Another significant issue is that almost all research on database integration presents pre-integration approaches using global schema techniques, which require complete integration. All local views are mapped by one global view. This method is convenient for users but it does not operate in the real-time manner because the global view must be created before query processing. As a result when only one object of a local system is modified, it affects the global schema requiring huge changes [4]. Furthermore, schema and semantic conflicts must be solved in the process of the global schema creation. The more data sources involved, the more difficult such conflicts are to be solved. This research focuses on the database and legacy integrating solution that avoids using the global schema pre-integration approach.

The Mediated Data Integration (MeDInt) Mediator is introduced in an attempt to overcome the above difficulties. It has been developed by focusing on providing a solution to interoperate heterogeneous data sources by transforming both the queries and the data transparently. Furthermore, this approach does not only solve schema and semantic heterogeneities, but also conflicts from different query languages and data models, namely data model heterogeneity.

II. Related Works

II.1 Conflicts and Resolution

Information from different sources can not be presented to users if it has not passed the process of conflict resolution. In terms of database integration, conflicts are differences of relevant data between component local database systems. The taxonomy of conflicts in this paper is divided into Schema conflicts and Semantic conflicts.

Schema conflicts are discrepancies in the structures or models of heterogeneous database management systems. Naming conflicts [8], Structural conflicts [4; 8; 9], and Identity conflicts fall into this conflict category. Naming conflicts are the synonyms or homonyms of objects in local systems. Structural conflicts are the different uses of data models to represent the same object. Identity conflicts occur when the different attributes, as a key, are used to access the same meaning information.

Semantic conflicts are discrepancies in the meaning of related data among heterogeneous systems such as Naming

conflicts, Representation conflicts [3; 4], Scaling conflicts [2], Granularity conflicts, Precision conflicts [1], Missing data, Scope conflicts, and Computational conflicts [2]. Naming conflicts are able to occur in data itself as well as in the structure of data. Representation conflicts or Format heterogeneities are the different uses of formats or data types to represent the same meaning objects. The different units of measurement generate Scaling conflicts.

From a survey of the literature, several methods to resolve conflicts have been found. In the case of Naming conflicts, a catalog [7], tables [4], or meta-data repository [1] can be used for maintaining these correspondences. An Object Exchange model [12] is able to transform semantics into simple structures that are powerful enough to represent complex information by using meaningful tags or labels. Kim [7] suggests three ways to resolve different representations of equivalent data: static lookup tables, arithmetic expressions, and mappings. In addition, a formulae has been suggested by Holowczak & Li [4] for converting values in one system to correspond with units in another system. They also introduce Superclasses to encapsulate each component database to create their relationships. Differences in attribute naming are solved by aliases [1; 4]. By using benefits of functions, Hongjun [5] proposes a data mining approach to discover data value conversion rules. Furthermore, independent views can be constructed to solve Structural conflicts. A view neither depends on any specific names nor on changes when schemas are modified [9].

II. 2 Integration Approaches

Numerous integration approaches have been introduced throughout the last twenty years to bring about the interoperability among heterogeneous systems. Missier, Rusinkiewicz, & Jin [10] categorise heterogeneity resolution methodologies into four main broad approaches: Translation, Integrated, Decentralised, and Broker based.

Translation approach needs highly specialised translation for each pair of local database systems. Therefore, the number of translators grows up exponentially especially when local systems increase. The development of these ad hoc programs is expensive in terms of both time and money.

In Tight-coupling approach or fully integrated approach, individual schema from multiple data sources is merged by one or more schemas. If only one schema is prepared, it is called a global schema approach. Otherwise, it is called a federated database approach. The global schema approach allows access of multiple data sources by providing the conceptual global schema as a logically centralised database [6]. Multiple local schemas are consolidated to create the global schema. Users are able to use one database language to query the global schema without understanding any local schemas. Generally, problems of heterogeneity must be resolved in the process of creating the global schema. A major difficulty is the process of creating global schema which thoroughly understands the differences between the independently-designed heterogeneous local schemas, and homogenises such differences [7]. This approach is more

difficult when the number of databases increases. Another approach, the federated database, also allows users to query more than one federated schema without knowledge of local data sources. This approach still requires complete pre-integration. The federated schema must be developed before issuing any queries, so any changes in local schemas would affect the federated schema.

Loose-coupling approach [2] or decentralized approach has been introduced in an attempt to resolve the problems arising from tight-coupling approaches by discarding either pre- or partial-integrated global schema. This approach allows users to query local database systems directly without any global schemas by placing the integration responsibility on users. Multi-database manipulation languages, which are capable of managing semantic conflicts through their specification, are provided as query language tools that are able to communicate with the local databases. Users can see all the local schemas and create their own logical export schema from selected schemas relevant to the information they need [3]. However, it requires users to have semantic understanding and to be able to resolve conflicts in creating their schema, which will be numerous with large numbers of data sources. In Broker-based approach, the crucial part is the conflict detector module using shared ontologies, but the process of doing those ontologies is not completely automated.

The limitations of the above integration approaches have led integration technologies towards a new variety of solutions. Various theories have been applied to solve integration problems such as the object-oriented model, knowledge base [11; 14; 16], ontology [13], and modeling [4].

III. THE Medint MEDIATOR

The research has introduced a heterogeneous database integration model incorporating a mediator and wrappers as intermediate layers between the application and data sources. The mediator, MeDInt (Figure 1), serves as an information integrator, between the application and wrappers. Generally, mediators are responsible for retrieving information from data sources, for transforming received data into a common representation, and for integrating the homogenised data [15]. In this model, the MeDInt Mediator acts as an interchangeable agent and facilitator for wrappers and clients. It consists of six components working together transparently to facilitate clients and data sources to achieve the following tasks:

- transforming and decomposing the submitted query into subqueries and then distribute them to associated wrappers;
- providing both schematic and semantic knowledge which is critical for query transformation and conflict resolutions;
- resolving conflicts; and
- consolidating query results.

All the functions above are served by six components (Figure 2), which are the Registering Processor (RP), the Query Transformation Agent (QTA), the Mediated MetaData

(MMD), the Conflict Resolution Agent (CRA), the Consolidation Processor (CP) and the Rendering Agent (RA).

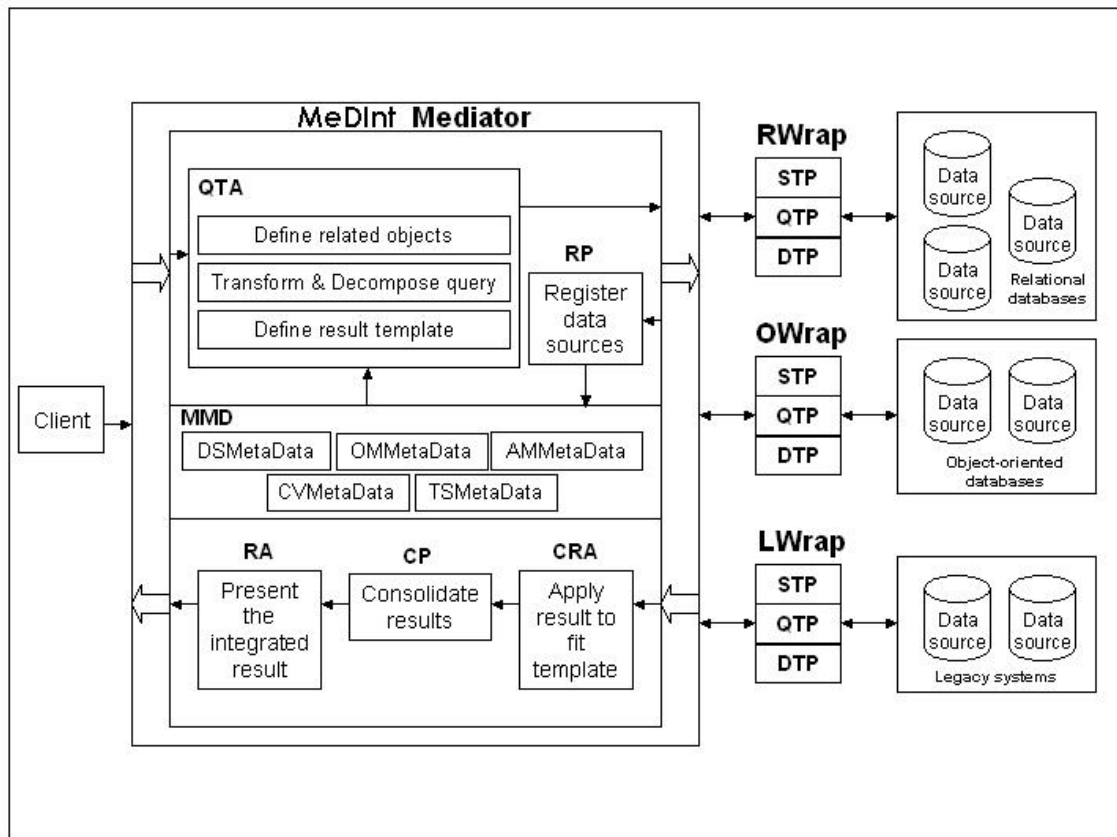


Figure 1. The MeDInt mediator

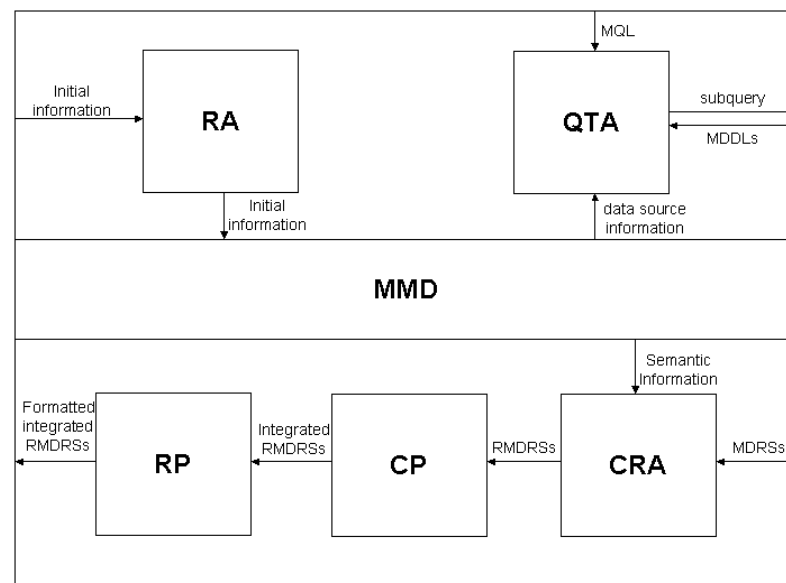


Figure 2. The six components of the MeDInt mediator

IV. MeDInt Processes

When a new data source is added to the integration system, it is registered to the Mediated MetaData (MMD). Data source information, for example, assigned name, location, type, description, and constraints relating to its structure and semantics are collected into the Data Source Metadata (DSMetaData), a category of MMD. A query from a user to retrieve the information from heterogeneous data sources is sent to the MeDInt Mediator instead of directly to the data sources. The required objects are determined and a request is submitted to the wrapper to get the related object schema definitions. The submitted query from the user is transformed to a specific query language appropriate to the database management system of the data source. A template for the results is created from the results obtained from multiple data sources. This method does not try to resolve conflicts directly which would be more difficult and complicated.

After getting a response data back from data sources, a component of a wrapper translates the query results into the Mediated Data Representation Structure (MDRS). The conflict resolution is done by applying all MDRSs to fit into the structure of the predefined template. The resultant MDRSs that are structurally equivalent are then integrated and consolidated. Finally the integrated result is sent to the user.

This approach overcomes the weakness inherent in other approaches that require the physical or logical integration of component schemas. Only the query result from each source, according to the result template, will be integrated instead. The template will be created from the submitted query. The resultant data from each data source will be applied to fit to the template which is the means by which the heterogeneities are resolved.

V. Wrapper Architecture

Wrappers are designed to handle data model heterogeneities arising from many different types of data sources. This includes the ability to deal with different schema definitions, different query languages, and different data representation structures. One novel feature of the approach is an attempt to reduce the amount of middleware modification when a data source is added, removed or modified. The approach is to map the foregoing objects to the Mediated Data Model (MDM), which is the common data model used in this research. The MDM, a way of facilitating the dealing of data model heterogeneities, consists of the Mediated Data Definition Language (MDDL), the Mediated Query Language (MQL), and the Mediated Data Representation Structure (MDRS).

A wrapper implementation is required for each different data model of a new data source. For m data sources comprising n different data models (where $n \leq m$) to be

integrated, this will only require n wrappers. This is much more favourable compared with the traditional translation approach in which $m*(m-1)$ translators are required. The computational efficiency is even more pronounced for higher values of m (for $n > 1$).

Figure 3 shows the area of responsibility of wrappers in relation to that of data sources. In this approach, objects and attributes are handled by the file/database management system of each data source. The data model heterogeneities are resolved and handled by wrappers.

Since the relational data model, the object data model and legacy text files are widely used in the real world, three wrappers are developed: an RWrap for the relational data model, an OWrap for the object-oriented data model, and an LWrap for legacy text files. Inside each wrapper (Figure 4), there are three algorithms serving as a Schema Translation Processor (STP), a Query Translation Processor (QTP) and a Data Translation Processor (DTP).

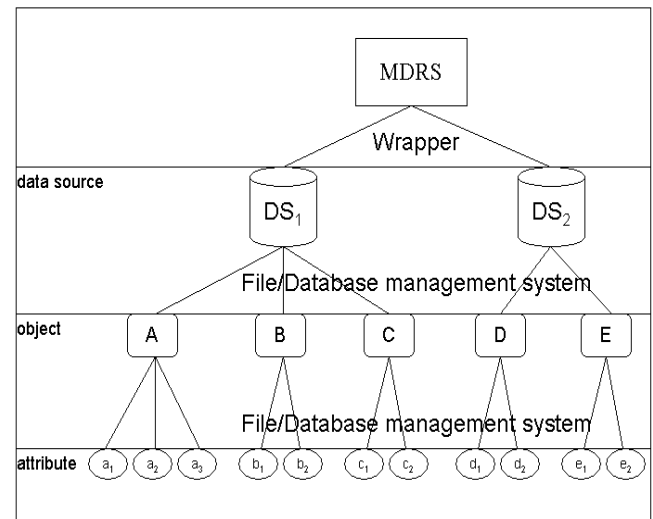


Figure 3. Data source and wrapper responsibility

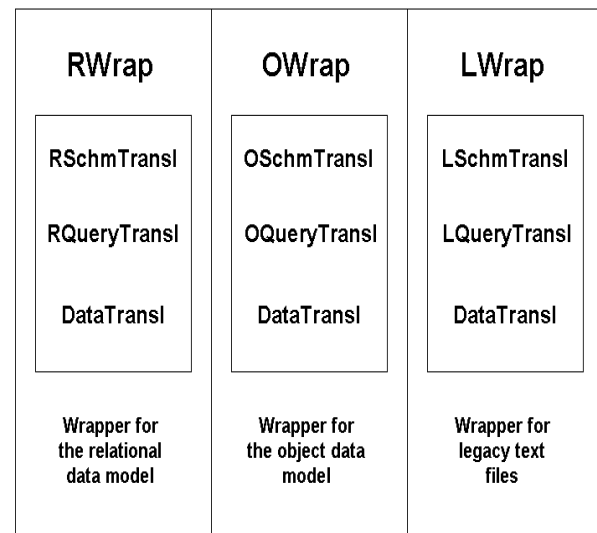


Figure 4. Three different wrappers

An STP translates schemas from the data source into the Mediated Data Definition Language (MDDL). A QTP is responsible for translating the Mediated Query Language (MQL) subqueries to a specific query to be processed by each data source. A DTP gets the query result from each data source, and then translates this into the Mediated Data Representation Structure (MDRS) where each unit is a set of required object attributes or properties.

VI. Results and Discussion

A number of example problems of heterogeneities from a number of information systems that require integration have been tested. The objectives are to demonstrate the integration process using the MeDInt mediator and to evaluate its correctness.

Test problem 1 is a Hotel Reservation Information System which provides information for travel agencies.

The information systems of contacted hotels need to be interoperated. Heterogeneities have been found when integrating them. The 2nd test problem is a university information system which is composed of a relational system and an object-oriented system.

The proposed MedInt Architecture and MDM have been tested for functionalities and the outcomes look promising. Results (Table 1) indicate that the objectives in resolving conflicts both structurally and semantically have been achieved. From the table mentioned above, the following three categories of heterogeneities have been determined: Model, Schema, and Semantic. All of them have been solved as shown by the MedInt with the support of the MDM (the Mediated Data Model has been developed in this study specifically for describing and representing heterogeneous data both schematically and semantically) which is suitable for homogenising different data models, schemas and semantics of component data sources. Another feature of our proposed model is that it can be implemented in any languages. We have chosen XML as the implementation language in the prototype because it offers a number of advantages. XML is platform independent, provides self-described tags which are easy to understand. It is also suitable for describing schema and semantic of objects in a real world since XML is based on an object-oriented model.

VII. Conclusion and Future Works

The research proposes the MeDInt Mediator as the framework based on the mediated approach for the integration of heterogeneous data sources to solve conflicts occurring when interoperability is required. The paper presents a new approach for achieving the interoperability of multiple data sources logically integrated at the time the query is issued. The system is able to describe or represent heterogeneous data both schematically and semantically. No pre-integration is required before users can issue their queries. This avoids the problem of local schema evolution

which usually happens in dynamic systems. Further investigations are planned to cover the query performance issues. Another possible future work is to incorporate the write access through the updating of master data sources and the replication of data sources.

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Table 1 Summary of the heterogeneities resolved by the MeDIInt mediator

Heterogeneities	Conflicts	Test Problem1	Test Problem2	
			Query 1	Query 2
Model		✓	✓	✓
Schema	Naming	✓	✓	✓
	Structural	✓	✓	
	Specialisation		✓	✓
	Relationship		✓	
Semantic	Naming		✓	
	Scaling	✓		✓
	Abstraction			✓
	Representation	✓		

A Web-Services-Based P2P Computing-Power Sharing Architecture

Chen-Sheng Wang, Po-Yu Yang, Min-Jen Tsai
Institute of Information Management, National Chiao Tung University
1001 Ta Hsueh Road, Hsinchu, Taiwan

cswang.iim92g@nctu.edu.tw, pyang.iim92g@nctu.edu.tw, mjtsai@cc.nctu.edu.tw

Abstract: As demands of data processing and computing power are increasing, existing information system architectures become insufficient. Some organizations try to figure out how to keep their systems work without purchasing new hardware and software. Therefore, a Web-services-based model which shares the resource over the network like a P2P network will be proposed to meet this requirement in this paper.

In addition, this paper also discusses some problems about security, motivation, flexibility, compatibility and workflow management for the traditional P2P power sharing models. Our new computing architecture - Computing Power Services (CPS) - will aim to address these problems. For the shortcomings about flexibility, compatibility and workflow management, CPS utilizes Web Services and Business Process Execution Language (BPEL) to overcome them. Because CPS is assumed to run in a reliable network where peers trust each other, the concerns about security and motivation will be negated.

In essence, CPS is a lightweight Web-Services-based P2P power sharing environment and suitable for executing computing works in batch in a reliable network.

I. Introduction

In the era of host computing, almost everything is done by mainframe computers. Processing in the mainframe often becomes a bottleneck in the information systems. Therefore, it forces enterprises to spend more money in upgrading mainframe system in order to keep up with increasing demands of computing power. Then, the client-server architecture is proposed to address such issue. The client-server architectures shift processing burden to the client computers. By workload sharing, client-server systems can maintain efficiency of the information systems while reducing the budget for computing resources.

Although client-server architectures have gained wide acceptance, increasing maintenance cost after system deployment push many companies to search for another ways to improve their processing power again without more investment in new hardware and software in a competitive market. In the meantime, some people try to think about how to use existing resource in the company such as idle computers or free storage space to reach the goal. This new approach is called peer-to-peer systems. It allows users to

make use of collective power in the network and benefit by lower costs and faster processing times.

Since P2P model is a system that allows users to share their resources with each other over the network, it is a matter to think about what kinds of computer resources can be shared. Thus, computer resources such as file system, network bandwidth and computing power are shared in some current P2P models. But there are some problems in existing P2P models, like lack of ability to customize computing tasks, workflow management etc.

To address these problems, this paper presents CPS - a lightweight Web-Services-based P2P power sharing environment which is suitable for executing computing works in batch in a reliable network. The architecture relies on BPEL to provide workflow management and on Oracle's BPEL Process Designer to provide a visual development environment. CPS also benefits from the characteristics of Web services, which are an open standard and loosely coupled.

II. Peer-To-Peer Model

The term "peer-to-peer" (P2P) refers to a class of systems and applications that collect distributed resources to perform a critical function in a decentralized manner. The resources could be computing power, data (storage and content), network bandwidth, and presence (computers, human, and other resources) [6]. Generally, there are three features in the P2P system: [1]

- A Computer can act as either client or server in the system.
- It allows users to make use of the collective power in the network
- A user benefits from lower costs and faster processing times in the system.

By employing P2P model, an organization can accumulate the existing resources to more powerful resources to satisfy increasing demands of processing power with economic expense. No matter how old the computer is, how narrow the bandwidth is and how less the storage is, many a little may make a mickle in the P2P network and it is what P2P model want to do.

There are two main categories of P2P system currently. One is file sharing (Napster) model and another is distributed computing (CPU power sharing) model [1].

File sharing model

According to [6], Content storage and exchange is one of the areas where P2P technology has been most successful. Distributed storage systems based on P2P technologies are taking advantage of the existing infrastructure to provide the features of file exchange, highly available safe storage, anonymity, and manageability.

Napster is the first P2P file sharing application that jump started the P2P area. Napster uses the centralized directory model to maintain a list of music files, where the files are added and removed as individual users connect and disconnect from the system. Users submit search requests based on keywords such as "title," "artist," etc. Napster has been quite popular. It has had more than forty million client downloads and has led to numerous variants of file-sharing applications [6]. Other famous model like E-Donkey, eMule and Bittorrent are also the examples of P2P file sharing systems.

Distributed computing

Another model of P2P system is distributed computing. This model tries to combine computing power to satisfy processing demands. It can shorten a long processing time without upgrading processing equipments. For example, in January 1999, a system with the help of several tens of thousands of Internet computers broke the RSA challenge [DES-III] in less than 24 hours using a distributed computing approach [3].

Distributed computing is often implemented in large-scale scientific researches. A famous one is SETI@home [5]. Up to October, 2005, this project has a consolidated power of about 40 TeraFLOPs/s (Thousands of Billions of floating point operation per second), collected from more than five million registered user machines [12].

In general, works which will be solved in a distributed computing system need to be split into small independent parts. Then, each part will be done by the specific software which is downloaded from central server and is run on participant computer. The results will be collected by a central server. Because the results are collected, the tasks are assigned by a central server and no direct communication occurs between participant computers (peers), someone argues that this architecture is not a purely P2P architecture [6].

III. Problems Analysis

Problems about distributed computing

Because distributed computing can integrate computing power over network to meet high processing demands such as large-scale scientific computing and process efficiently, it is suitable to process complex tasks. Nevertheless there are some problems which make small-scale organizations hard to pursue this architecture. These issues are discussed as follows.

- **Security**

Security in the distributed computing model is based on trust. Participants must completely trust the research organization before they download the programs because to allowing unknown programs running on your own computer is greatly exposed to security breaches. A malicious attacker may add or delete files on the computer, or connect to other computers and perform illegal operations by attacking vulnerability on the computer. It is very difficult to secure P2P applications against such misuse, but if the patrons of P2P project are famous like Intel and the University of Oxford sponsoring the Cancer Research Project in UD, reliance on safety of their computers will be enhanced.

- **Motivation**

Participants who take part in distributed computing only want to make some contribution to the world and do not ask any pay back. In many companies, there are thousands of idle computers on 5:00 PM between 9:00 AM. Why do we use them to process something? Someone argue that those equipments are exclusive assets for companies and it is not necessary to do something that is not beneficial to them. Similarly, general participants do not hope to join the projects with commercial purposes. To gain the participant's confidence and attract them to participate, some famous P2P systems like UD - a cancer research project - announce their research results do not belong to any commercial originations.

- **Flexibility**

In order to contribute, participants must download the specific program which is developed for that project and install it on their computers to donate CPU power. Once that program needs to be updated to do new research, the tightly-coupled relationship between participating program and central server would make it hard to update all the programs around the world efficiently. In addition, such kind of project can not let participants design their own tasks and execute them in the system. Although grid computing provide such service, a command-line but not a visual interface to use the service will make participants feel less friendly.

- **Compatibility**

Compatibility of participating programs across different platforms is another problem. Some participating programs, such as ones in UD project are only run on NT-compatible platforms. However, there are a large number of workstations that use Unix or other as operating systems. It will be a pity that those workstations can't join this project due to compatibility. Although some distributed computing systems like SETI@home solve this problem by developing different versions of the program for different platforms, it will increase the maintenance cost as many versions of the program must be developed and updated.

- **Workflow Management**

What most of Grid or P2P distributed computing middleware focuses on is performance, workload balance or

stability but hardly workflow management. With workflow management, a complicated job which is composed of many small tasks can be executed in parallel or sequentially. At present, it is not natively supported by most models.

Available Solutions

According to the issues mentioned above, the paper presents some available solutions or technologies to address these problems.

Asynchronous Web Services

Web Services is a software development solution based on Services Oriented Architecture (SOA) in Figure 1. A Web-services-based system can inherit the features of Web Services which are loosely coupled and open standard. If a computing system is implemented by Web Services, it will not only improve flexibility of software updates in the system because of loosely-coupled relationship between service consumer and provider but also be easily to communicate because of open standard.

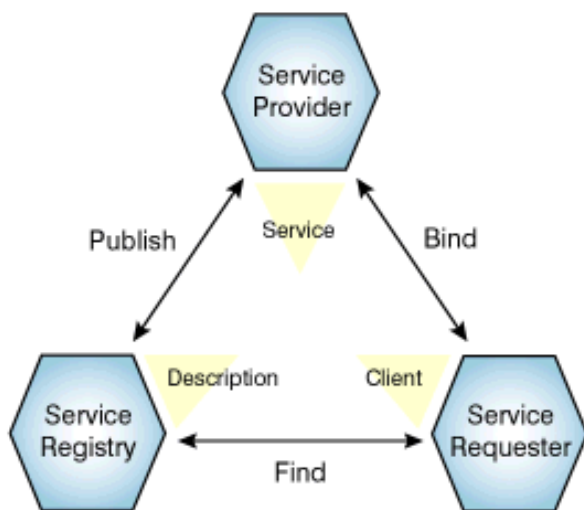


Figure 1 Architecture of Web Services [4]

Web Services is a message-based architecture and the interaction between services can be synchronous or asynchronous. In essence synchronous Web Services is not suitable for distributed computing system because it is hard to estimate the processing time in the system and it may cause timeout exception. Therefore, asynchronous Web Services [7,8,9] should be applied in the system to avoid over-time exception because it is usual to wait for response until tasks finished in distributed computing environment. The problem of flexibility will be addressed by using asynchronous Web Services to implement distributed computing system.

Business Process Execution Language (BPEL)

BPEL [9,13] is a de facto standard of Web Services composition and integrated by IBM and Microsoft from WSFL and XLANG. It has the characteristics such visual

development, workflow management, exception and transaction handling and compatibility with Web Services [2].

Based on the characteristics of Web Services, BPEL is suitable to solve the issues of a visual development environment and workflow management in distributed computing system. In addition, a complicated job can be tackled by Web services composition which BPEL aims to address and can be easily executed by BPEL engine.

Implementation in a trusty network

As discussed in last section, security in distributed computing system is based on trust. So, it will be easy for famous and large originations to sponsor P2P distributed computing project but not for small-scale and medium-scale companies. However, if we think from the perspective of an organization, how about using idle computers in the origination to process what the origination want to compute. In other words, it is implementation in a trusty network.

In this paper Trusty network is defined as a network where peers trust each other. No matter the intranet of an origination or computer network of the friends, it can be classified as trusty network if the peers in the network trust each other. Our lightweight distributed computing system is assumed to implement in a trusty network. Thus, the concerns about security and motivation can be negated.

IV. The Architecture of Computing Power Services

Based on the possible solutions in last section, this paper proposes the CPS architecture, which is a Web-services-based P2P architecture as shown in Figure 2. It provides users a platform to design the business processes and control workflow of the processes by using the visual characteristics of BPEL. The architecture is assumed to be implemented in the trusty network to execute the computation-intensive tasks by using the idle computing power in the enterprises.

The Model of Web-Services-Based Power Sharing

The key point of CPS is how to assign the jobs in distributed computing environment. Intuitively, the computing requester should search for the computing units and give them the tasks to do. If CPS is implemented so, each computing unit will need to publish a Web service as accessing point. It will mean an application server will be necessary to host a Web service.

However, such environment will be too complicated for users to provide computation and it will discourage users to participate the project. Hence, to comply with the concept of thin client and encourage users to provide their computing power, this paper makes the computing unit as service requester and the computing requester as service provider.

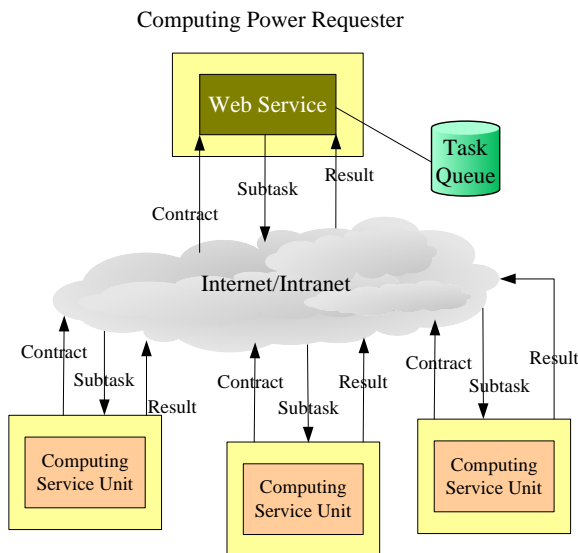


Figure 2 Architecture Diagram of CPS

The Roles of CPS Architecture

Because CPS bases on the architecture of Web services, it will inherit the characteristics of SOA which consists of 3 participants that are service requester, service provider and service broker. However, in order to make the program developed in CPS as thin as possible, 3 participating roles will be changed slightly to meet the requirement discussed in last section. The description of 3 roles will be explained in the following section.

● The role of Coordinator

The coordinator acts as a service broker to fairly mediate between the computing unit (service requester) and computing requester (service provider). Its main function is to maintain a list which records the URL and requirement of computing requester. This list will be created when the computing requester publishes its Web service in the coordinator. If computing unit asks for the subtasks through the coordinator, the coordinator will assign the URL of computing requester in the list to computing unit by round-robin mechanism. Afterward, the computing unit will use the specified URL to communicate with the computing requester directly.

In addition, the function of account and auditing management will be implemented at the end of coordinator. This role is corresponding to the role of UDDI in SOA.

● The role of Computing Power Requester

The requesters design their processes by a BPEL visual development environment. After designing, the requester will publish their requirement at the end of coordinator. If computing unit asks for the subtasks through the coordinator, the coordinator will assign the URL of computing requester in the list to computing unit by round-robin mechanism. Afterward, the computing unit will use the specified URL to communicate with the computing requester directly.

In addition, the function of account and auditing management will be implemented at the end of coordinator. This role is corresponding to the role of UDDI in SOA.

● The role of Computing Unit

This role is responsible for execute computation. It will inquire the coordinator to ask for the job when it is idle. After getting back the requester's URL of Web services, it negotiates with the requester to download the task and required files for that task. Then, it starts to execute the task and respond the result to the requester when the task is finished. The whole procedure will continue until all tasks are done.

The interaction among roles and the operating procedures of CPS are described by Figure 3 below.

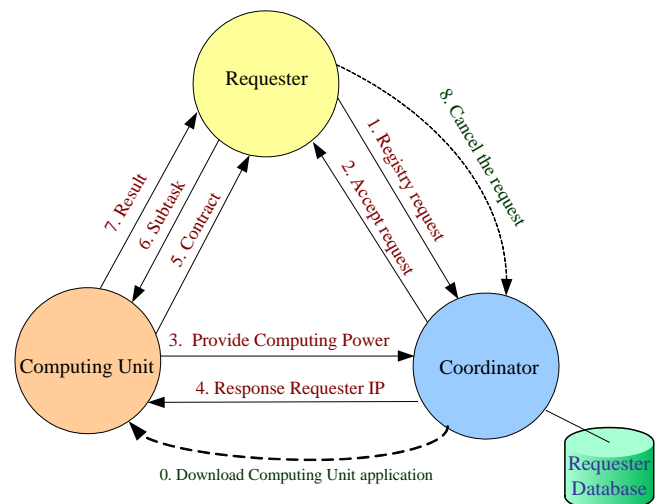


Figure 3 Operation Diagram of CPS

The System Architecture of CPS

The Figure 4 is the diagram of CPS architecture. By functionality, the architecture is divided into 5 layers, which are the User Layer, the Power Sharing Layer, the Communication Layer, the Contract Layer and the Discovery Layer.

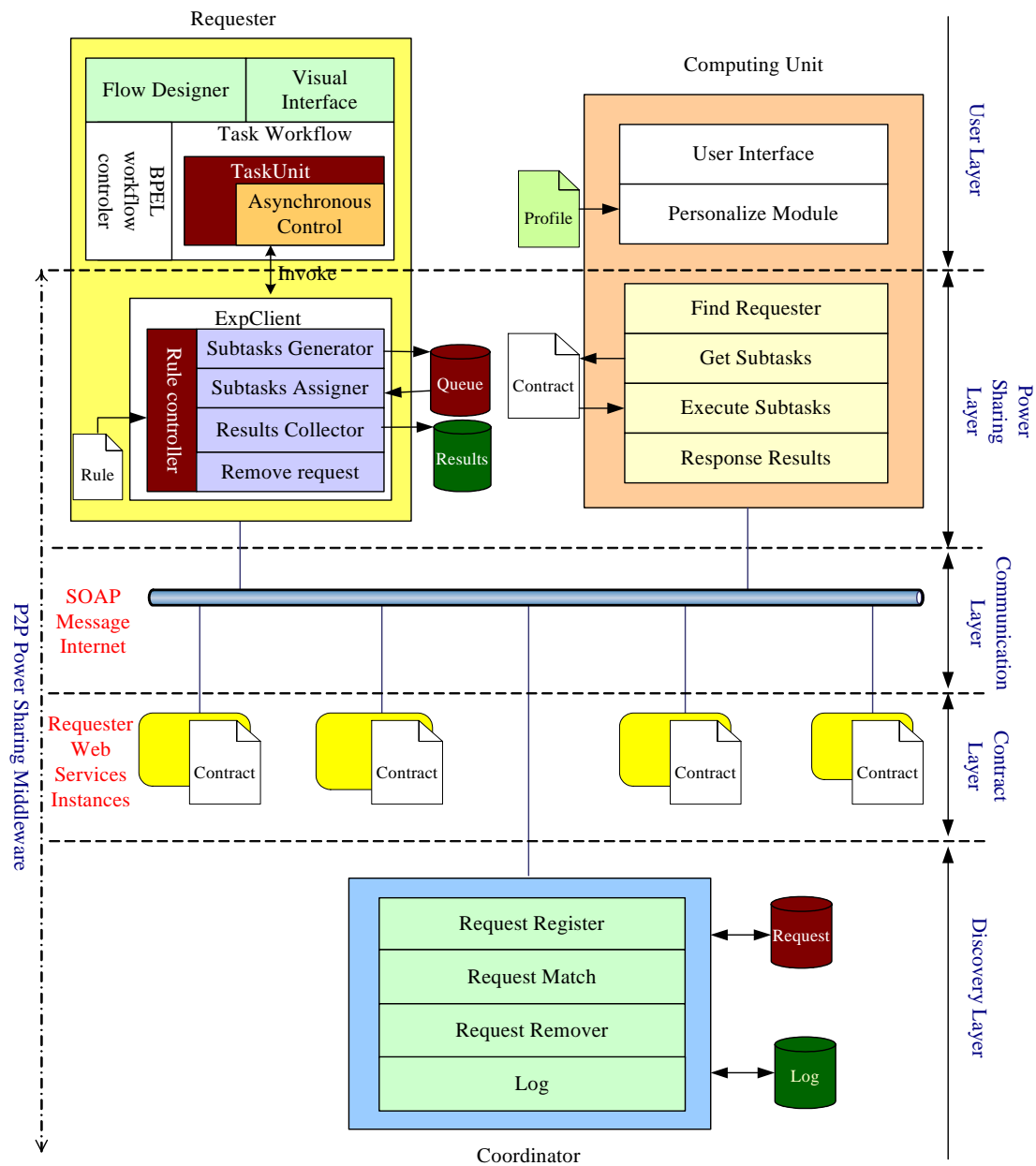


Figure 4 The Layer Diagram of CPS Architecture

P2P Power Sharing Middleware

Excluding the User Layer, the other 4 layers comprise the P2P Power Sharing middleware which is the core of CPS.

Because CPS is based on Web services, the middleware is also established by the protocols of Web services as the Figure 5 shows.

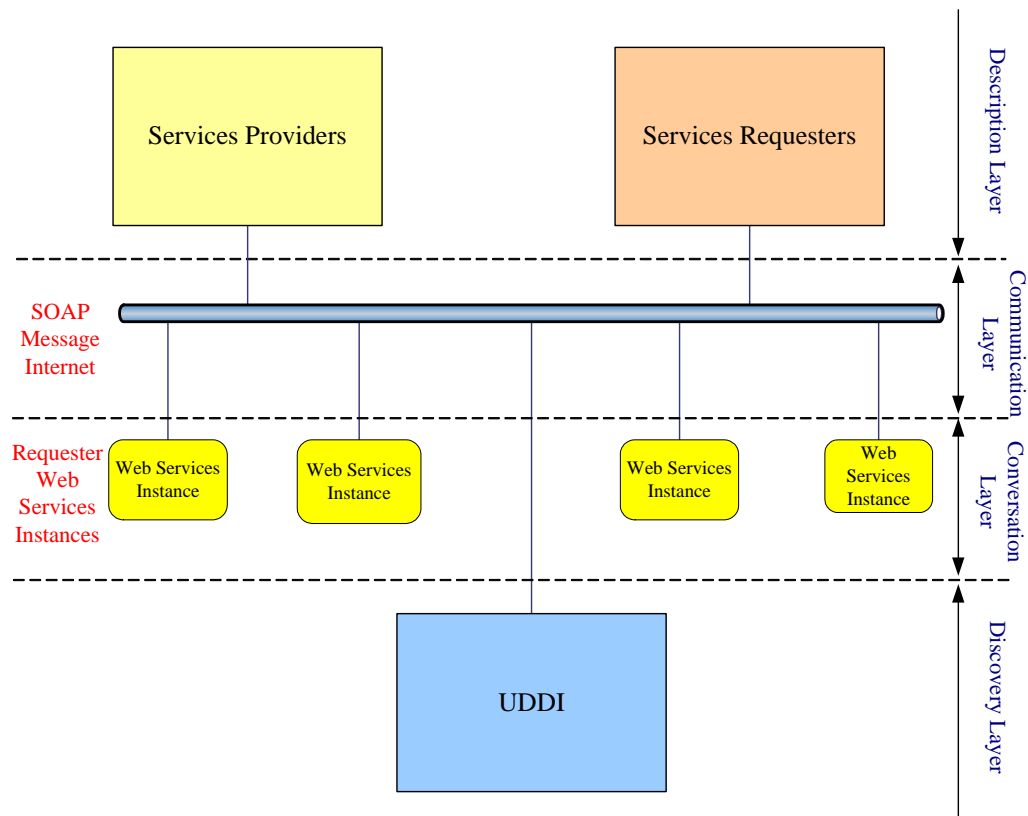


Figure 5 The Diagram of P2P Middleware in the CPS Architecture

- The User Layer

The users access the whole architecture in this layer. This layer will be implemented at the end of requester and computing unit. While, at the end of computing unit, it provides an interface to control the execution of the program, it will allow user to design the BPEL process at the end of the requester. Besides, it also provide GUI interface to facilitate the designing and managing the workflow of the process.

- The Power Sharing Layer

This layer corresponds to the Description Layer of Web services. It describes the interaction between the requester and the computing unit.

- The Communication Layer

This layer uses the communication mechanism of Web services, i.e. SOAP.

- The Contract Layer

The conversation between a computing unit and the requester will be defined by the contract in this layer.

- The Service Discovery Layer

The coordinator operates in this layer as a broker agent for the requester and computing unit. The coordinator will not involve the computing.

The Interaction between User Layer and P2P CPS Middleware

By using BPEL as a language to develop the process, CPS provides the environment of visual development and the capability of workflow management. However, BPEL doesn't support the distributed computing. Therefore, this paper develops a TaskUnit program which interacts with P2P CPS middleware to address this issue.

Actually, TaskUnit is a process developed by using BPEL. It can be viewed as the process of task dispatcher to provide the capability of distributing computing. It comprises of 2 modules. While One module is to invoke a ExpClient Web service, another module will asynchronous receives the result sending by P2P CPS middleware.

The Figure 6 describes the interaction between TaskUnit and P2P CPS middleware.

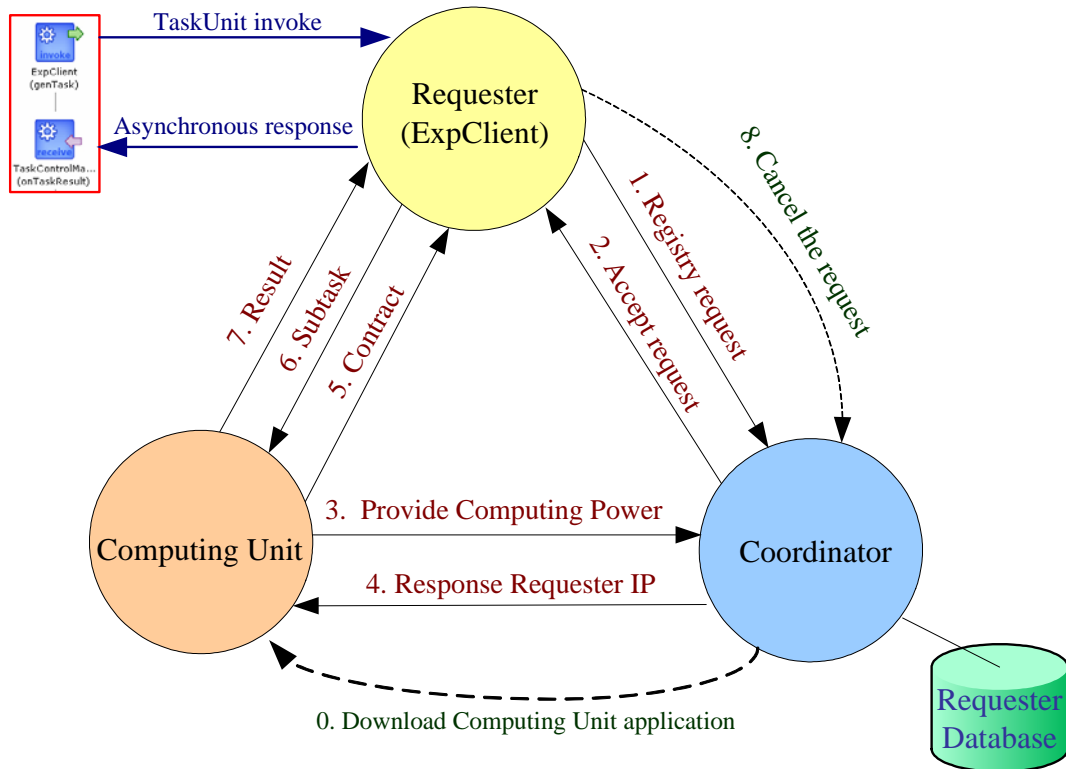


Figure 6 The Interaction Between TaskUnit and P2P Middleware

The Mechanism of Exception Handling

There are two possible exceptions when CPS operates. The one is that a user closes the program at the end of computing unit, the other is that the computing unit can not finish the task before time-out. To address both exceptions, CPS employs the mechanism of task reassigning after time-out and roll-back at the end of computing end.

The Assigning Rule at the End of Requester

The flowchart of assigning subtasks at the end of requester is indicated in Figure 7. In general, the mechanism of assigning subtasks will distribute the unassigned subtasks to the computing unit. If all subtasks are assigned, the requester will use the mechanism of reassigning subtasks to find the time-out tasks. The length of time-out timer will be defined in the assigning rules.

Although CPS can handle the breach of contracts by using the mechanism of reassigning subtasks, it will cost more resources to redo the tasks.

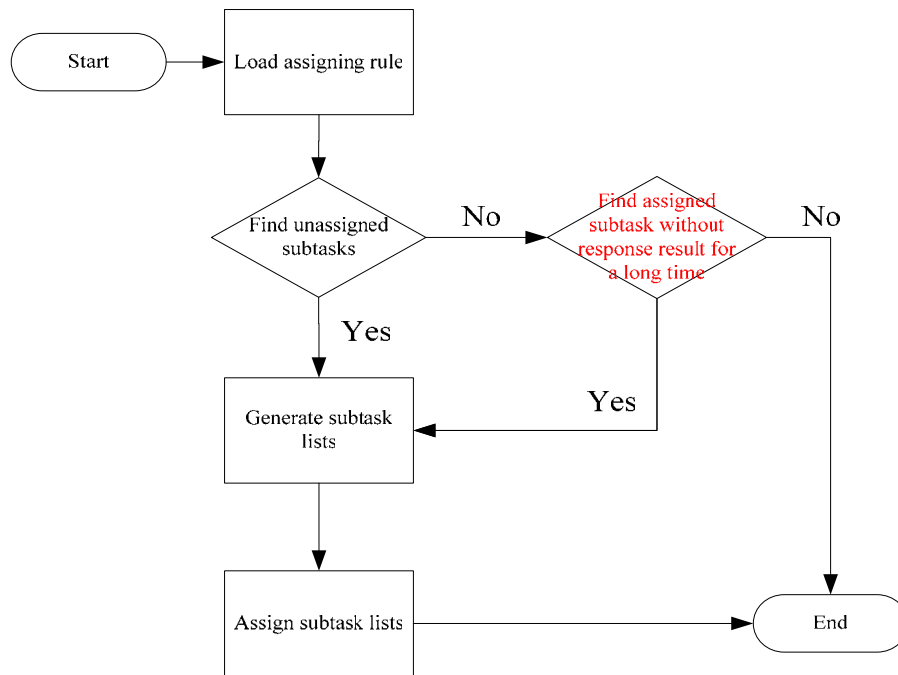


Figure 7 The Flow Chart of Assigning Subtasks at the End of Requester

The Roll-Back Mechanism at the End of Computing Unit

As Figure 8 depicts, the program at the end of Computing Unit will perform computation according to the contract. After finishing the subtask, it will reply the result to the requester, terminate the contract and remove results. If the program is abnormally terminated, the contract still exists at

the end of Computing Unit. Therefore, as soon as the program starts, it will verify existence of the contract. If it does, the program will remove the previous result and do computation again. Although this paper adopts the conservative way to roll back the computation, it guarantees finishing the contract.

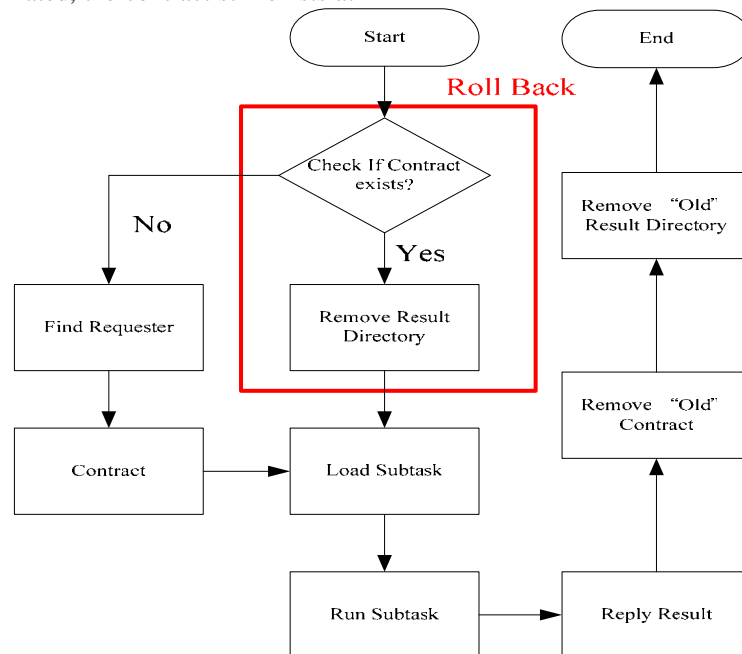


Figure 8 The Flow Chart of Executing Subtasks and Roll-back at the End of Computing Unit

V. Implementation and Result

System Implementation

As Figure 9 depicts, CPS is implemented in the trusted network to utilize the idle computing power. The coordinator publishes a Web service to provide the list of requiring

computing power as the access point of CPS. As for the requester, it uses Oracle Process Manager Server [11] to host BEPL engine and Oracle PM designer with Eclipse to provide GUI interface for designing and management. Meanwhile, a low-priority program is run at the end of the computing unit to execute the task from the requestor. The purpose to lower the priority of a program is to avoid impacting the routine work of the computing unit.

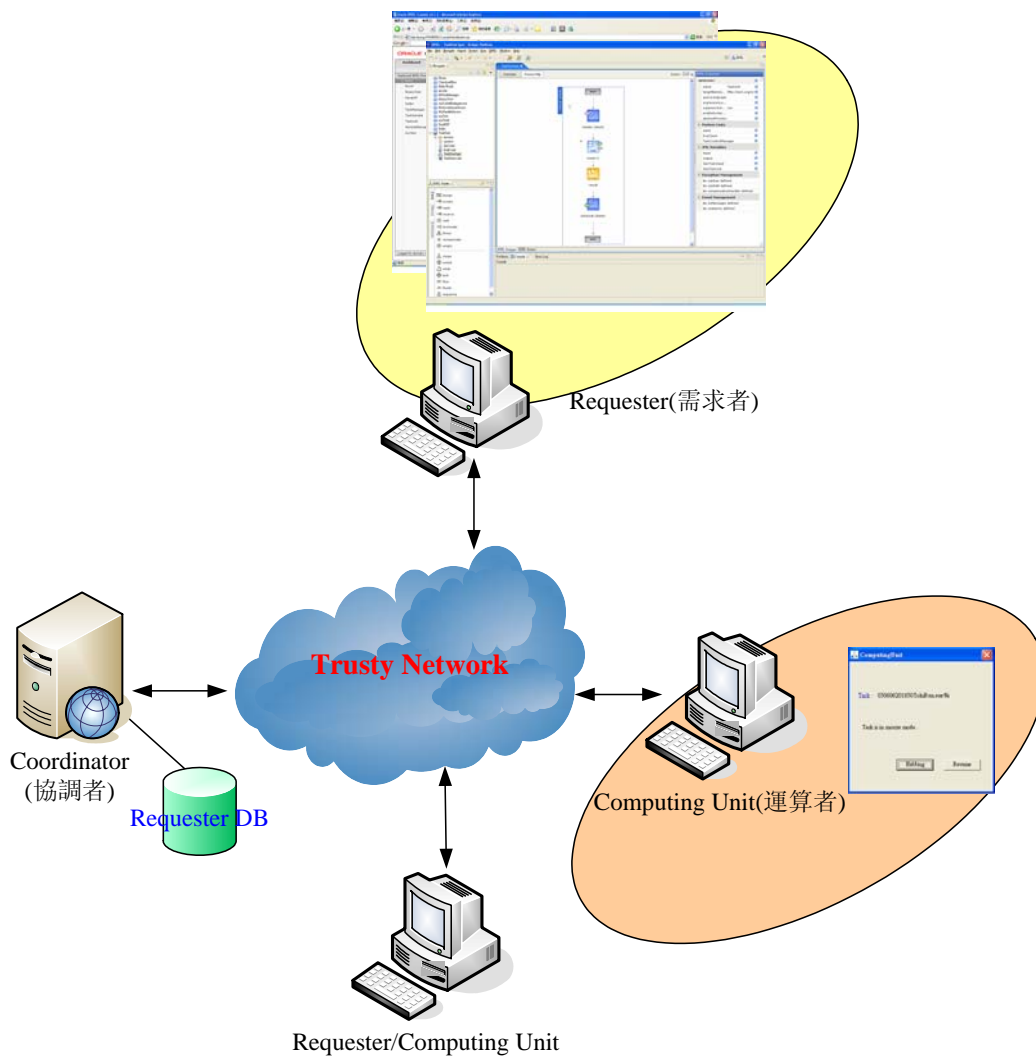


Figure 9 The Deployment Diagram of CPS

Result

To verify the architecture, a lab is arranged to test CPS on executing the program from [14]. This program will extract the watermark by using 76,177 filers which will be grouped into several subtasks with a group having 100 filters. By using the similar computers at the end of computing unit, the

total computing time versus the number of computers involved to finish the lab is graphed in Figure 10.

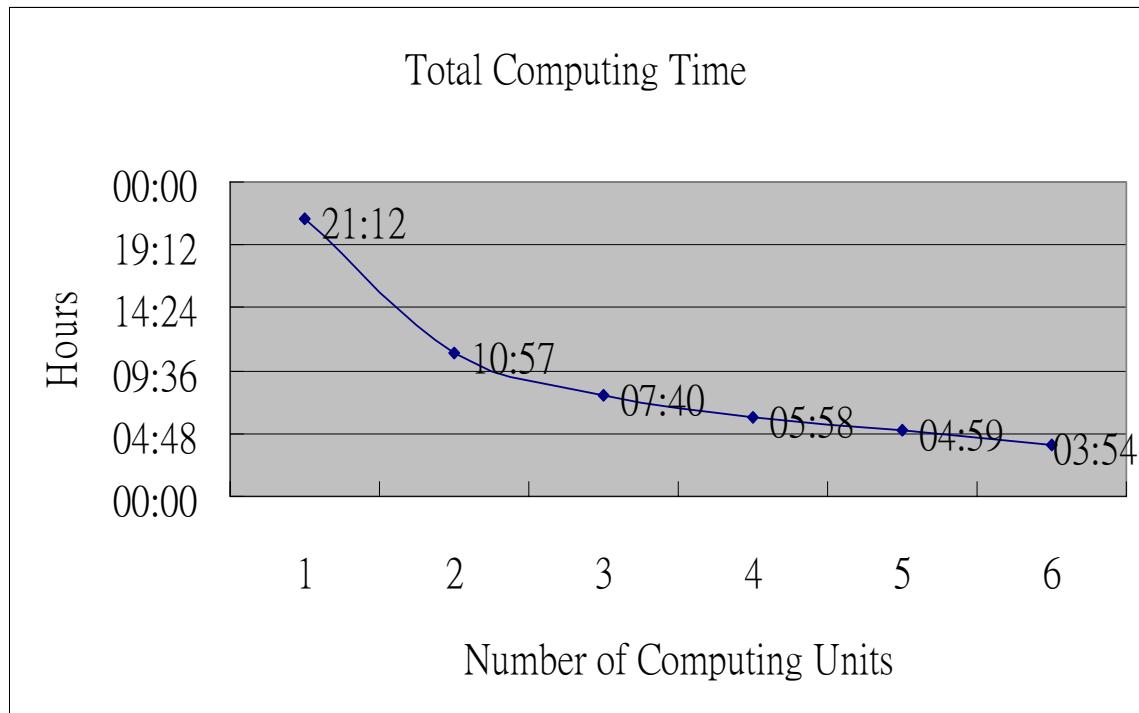


Figure 10 The Computing Time to Finish the Lab

According to [14], one computer will spend about 20 hours to finish the specified lab. If the number of filters is increased to 1,628,250 and each group consists of 500 filters, one computer will need 18 days to finish the lab. However, CPS will shorten the computing time to 2 days 14 hours 13 seconds to do the same lab. The deducting ratio is almost 1/9. As a result, CPS indeed helps executing a computation-intensive task.

VI. Conclusions

This paper presents the architecture of CPS which employs the protocols of Web services to address the flexibility issues of current P2P computing, uses BPEL to control the workflow of the process and provides a user-friendly environment to design the process. In addition, the architecture is assumed to perform in the trusted network to avoid the security issue.

Such a lightweight architecture is especially applicable to the batch programs which need intensive computing power and appropriate to the enterprises which can efficiently utilize their computing power after the office hours. Besides, it also provides a graphical designing and management environment to the enterprises.

Future Works

● Workflow Management

Currently, the mechanism of Roll-Back will redo the unfinished task when an exception occurs. The purpose to do so is to guarantee the contract is performed exactly. However, it will consume more resources to finish the same task. Therefore, how to efficiently continue the interrupted task will be a future work to address.

● Process Optimization

Although CPS shortens the computing time, is it an optimized solution? In Figure 11, there are 4 computing units A, B, C and D assigned to execute a process. Each colored block means the computing time needed to finish one subtask. If A and D ask the requester to assign a new subtasks at the same time when only 2 subtasks are left to finish, the requester will assign one subtask to A and D when the round-robin mechanism is used. Then, the total computing time will be depicted in Figure 11 (a). However, if the dynamic mechanism such as assigning the subtask according to the previous computing time, both subtasks should be assigned to D because it finishes the subtask faster. Then, the more optimized solution is concluded in Figure 11(b).

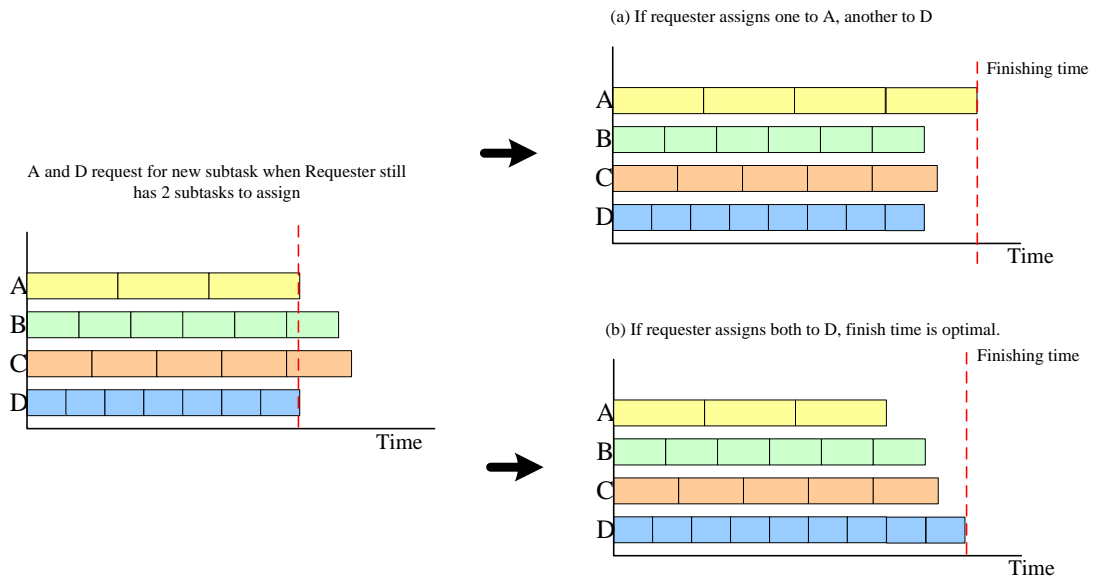


Figure 11 The Optimized Task Assignments of a Process

In addition, BPEL provide the capability to run the subtasks in parallel. Hence, the work to find the more optimized solution which finishes the parallel process is a topic deserved to research.

● BPEL Virtual Machine

In essence, BPEL could be though as programming language of the process. Therefore, BPEL virtual machine could be designed to execute the process. Doing so, the BPEL virtual machine will be downloaded to the computing unit and the subtask will be the fragment of BPEL document that could be executed in the virtual machine. Then, the issue of cross platform could be addressed.

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A Lagrangean Relaxation Based Scheme for Allocation of Bandwidth

Indranil Bose

Room 730 Meng Wah Complex School of Business
The University of Hong Kong, Pokfulam Road, Hong Kong
Phone: (852)-2241-5845, Fax: (852)-2858-5614
e-mail: bose@business.hku.hk

Abstract: In this paper we study the bandwidth packing problem in the presence of priority classes. The bandwidth packing problem is defined as the selection and routing of messages from a given list of messages with prespecified requirements on demand for bandwidth. The messages have to satisfy delay constraints and have to be routed over a network with given topology so that the revenue generated from routing these messages is maximized. Messages to be routed are classified into two priority classes. An integer programming based formulation of this problem is proposed and a Lagrangean relaxation based methodology is described for solving this problem. Several numerical experiments are conducted using a number of problem parameters such as percentage of messages, ratio of messages of lower to higher priority, capacity of links and high quality solutions to the bandwidth packing problem are generated under the different situations.

Keywords: Optimization under uncertainty, Bandwidth, Heuristic, Lagrangean relaxation.

I. Introduction

Networks of today often suffer from congestion problems due to the tremendous increase in traffic in recent times as well as irrational allocation of bandwidth to support this increased traffic. One of the fundamental problems related to design of networks is determination of which messages to route among a given list of messages and determination of the routes to be used for delivering messages between communicating nodes so that the revenue generated from routing these messages is maximized. This is known as the bandwidth packing problem. The objective of this research is to use an optimization based approach for solving the bandwidth packing problem for messages belonging to multiple service classes. This will involve selection of a target group of messages from a list of messages with different delay requirements provided by the users, and determination of the best paths for routing these messages. Usually the topology of the network, the capacities of the links, the revenues to be generated by routing the messages, and the demand requirements of the messages are specified prior to the start of network design. The messages are listed in the form of a message table. In this table, the messages are prioritized based on the demand requirements. Since the

network capacity is usually insufficient to route all messages, a selected group of messages are routed during a given period of time. This is also known as the static bandwidth packing problem (as opposed to dynamic bandwidth packing where the demand requirements of the messages change over time) and is studied in this paper. Our goal in this paper is to find an appropriate message selection and routing scheme that provides an efficient resource allocation mechanism and maximizes the revenue generated from the usage of the network.

Various versions of the bandwidth packing problem have been studied in the literature. This includes research conducted by Amiri and Barkhi [1], Amiri et al. [2], Anderson et al. [3], Cox et al. [4], Laguna and Glover [5], Park et al. [6], Parker and Ryan [7], and Rolland et al. [8]. Most of these papers strive to maximize the revenue earned by routing the messages subject to some service related constraints. A notable exception is the paper by Amiri et al. [2] where the objective is to maximize revenue as well as minimize the delay cost associated with the use of the network. Various methods are used in these papers including tabu search [3,5], genetic algorithms [4], column generation [6,7], and Lagrangean relaxation [1,2,8]. However, the available research on bandwidth packing considers only a single message class. This assumption is not realistic as users may use the networks for running different applications. Some of these applications may be delay sensitive but others may be not. So it is more realistic to model the bandwidth packing problem in the presence of multiple priority classes. To the best of our knowledge, this is the first paper that addresses the priority bandwidth packing problem. As opposed to the existing literature this problem is considerably more difficult because exact analytical expressions for the average delay of the priority classes are difficult to obtain and this in turn complicates the formulation of the problem.

II. Problem Formulation

We introduce the following notation for developing an integer programming model for the priority bandwidth packing problem:

- N the set of nodes in the network
- E the set of undirected links (arcs) in the network
- M the set of messages
- M_1 the set of messages with lower priority
- M_2 the set of messages with higher priority
- $M = M_1 \cup M_2$

- $1/\mu_1$ average length of messages with lower priority
- $1/\mu_2$ average length of messages with higher priority
- d^{m_1} the demand for message $m_1 \in M_1$
- d^{m_2} the demand for message $m_2 \in M_2$
- r^m the revenue from message $m \in M$
- $O(m)$ the source node for message $m \in M$
- $D(m)$ the destination node for message $m \in M$
- Q_{ij} the capacity of link (i, j)
- δ_1 the upper limit on number of messages of lower

priority in the network

- δ_2 the upper limit on number of messages of higher
- priority in the network

- $L_{ij}^{m_1}$ number of messages of lower priority on link (i, j)
- $L_{ij}^{m_2}$ number of messages of higher priority on link (i, j)

The decision variables are:

$$Y_m = \begin{cases} 1 & \text{if call } m \text{ is routed} \\ 0 & \text{otherwise} \end{cases}$$

$$X_{ij}^m = \begin{cases} 1 & \text{if call } m \text{ is routed through a path that uses link } (i, j) \\ 0 & \text{otherwise} \end{cases}$$

$$W_{ij}^m = \begin{cases} 1 & \text{if call } m \text{ is routed through a path that uses link } (i, j) \\ & \text{in the direction of } i \text{ to } j \\ 0 & \text{otherwise} \end{cases}$$

In order to obtain a mathematical formulation of the bandwidth packing problem we have to make several assumptions. These are listed below:

- The nodes have infinite buffers to store messages waiting for transmission
- Arrival process of messages entering the network follows a Poisson distribution
- Length of messages follows an exponential distribution
- Propagation delay in the links is negligible
- The average message length for each type of messages is used instead of using individual message lengths
- The link and message system is studied as a preemptive priority queue, i.e., the routing of lower priority of messages can be interrupted by higher priority messages

Based on the above assumptions, the telecommunication network is modeled as a network of M/M/1 queues. In this network, links are treated as servers with service rates proportional to the link capacities. The messages are treated as customers waiting to be routed at a particular node. If we measure delay in terms of messages, then the delay is defined as the total number of messages to be routed on a particular link. Since we want to limit the upper bound of delay, we can use a relaxed formulation of the delay in terms of maximum number of allowable messages on a link for priority 1 and priority 2 messages. We denote them by $L_{ij}^{m_1}$

and $L_{ij}^{m_2}$ respectively. The nature of the problem imposes certain restriction upon the characteristics of higher priority messages. Usually, they are shorter in length than low priority messages, i.e., $a = \mu_1 / \mu_2 \leq 1$. In addition, the higher priority messages generate more revenue while they are not as tolerant to queuing delay as the lower priority messages (i.e., $\delta_1 \leq \delta_2$). With the notations defined and queuing delay formulated, we can now model the bandwidth packing problem as follows:

Problem P

$$\text{Max } \sum_{m \in M_1, M_2} r_m Y_m \quad (1)$$

Subject to:

$$\sum_{j \in N} W_{ij}^m - \sum_{j \in N} W_{ji}^m = \begin{cases} Y^m & \text{if } i = O(m) \\ -Y^m & \text{if } i = D(m), i \in N \text{ and } m \in (M_1, M_2) \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

$$W_{ij}^m + W_{ji}^m \leq X_{ij}^m \quad \forall (i, j) \in E \text{ and } m \in (M_1, M_2) \quad (3)$$

$$\sum_{m_1 \in M_1} d^{m_1} X_{ij}^{m_1} + \sum_{m_2 \in M_2} d^{m_2} X_{ij}^{m_2} \leq Q_{ij} \quad \forall (i, j) \in E \quad (4)$$

$$\sum_{(i, j) \in E} L_{ij}^{m_1} \leq \frac{(Q_{ij} - \sum_{m_2 \in M_2} d^{m_2} X_{ij}^{m_2}) \sum_{m_1 \in M_1} d^{m_1} X_{ij}^{m_1} + a \sum_{m_1 \in M_1} d^{m_1} X_{ij}^{m_1} \sum_{m_2 \in M_2} d^{m_2} X_{ij}^{m_2}}{(Q_{ij} - \sum_{m_1 \in M_1} d^{m_1} X_{ij}^{m_1} - \sum_{m_2 \in M_2} d^{m_2} X_{ij}^{m_2})(Q_{ij} - \sum_{m_2 \in M_2} d^{m_2} X_{ij}^{m_2})} \quad (5)$$

$$\sum_{(i, j) \in E} L_{ij}^{m_2} \leq \sum_{(i, j) \in E} \frac{\sum_{m_2 \in M_2} d^{m_2} X_{ij}^{m_2}}{(Q_{ij} - \sum_{m_2 \in M_2} d^{m_2} X_{ij}^{m_2})} \leq \delta_2 \quad (6)$$

$$Y^m \in (0, 1) \quad \forall m \in (M_1, M_2) \quad (7)$$

$$X_{ij}^m \in (0, 1) \quad \forall (i, j) \in E \text{ and } m \in (M_1, M_2) \quad (8)$$

$$W_{ij}^m \in (0, 1) \quad \forall (i, j) \in E \text{ and } m \in (M_1, M_2) \quad (9)$$

The objective function (1) represents the total revenue earned from the routing of messages. Constraint set (2) represents flow conservation equations, which define a route for each message represented by a communicating node pair. Constraint set (3) links together the X_{ij}^m and W_{ij}^m variables. Actually, the problem can be correctly formulated with either X_{ij}^m or W_{ij}^m variables only. The constraint set (3) is redundant but useful for Lagrangean relaxation. Constraint set (4) guarantees that total flow does not exceed link

capacities. Constraints (5) and (6) impose upper bound on the number of messages belonging to each priority class for each link. Constraint sets (7), (8) and (9) are the integrality constraints of the decision variables.

III. Solution Procedure

Problem P is a combinatorial optimization problem with non-linear constraints. It is known to be a NP-complete problem. So we propose a heuristic based on the Lagrangean relaxation by dualizing constraint set (3) using non-negative multipliers α_{ij}^m for all $(i, j) \in E$ and $m \in (M_1, M_2)$, then further dualizing constraints (5) and (6) using non-negative multipliers ψ_1 and ψ_2 . The resulting Lagrangean relaxation of Problem P is further simplified by decomposing it into several message sub-problems and link sub-problems. Each message sub-problem resulting from the Lagrangean relaxation can be solved by solving the shortest path problem from $O(m)$ to $D(m)$ using the non-negative multipliers α_{ij}^m as the cost of the links. If the revenue from the message is greater than the cost of the shortest path, then the message is routed through that path, otherwise, the message is not routed and we set $Y^m = 0$ and $W_{ij}^m = 0 \quad \forall (i, j) \in E$. On the other hand, for solving each link sub-problem we relax the integrality constraints and solve the continuous version of the problem using a greedy procedure. The solution obtained from solving each sub-problem is added up to give the upper bound of the optimal value of problem P. The feasible solution gives the lower bound of the maximization problem. The difference between the upper and the lower bound gives the gap in the solution and is a measure of how close the algorithm can approximate the optimal solution. The gap is usually calculated as a percentage gap. Like all relaxation procedures, the success of a tight lower bound depends heavily on the ability to generate good Lagrangean multipliers. In practice, the subgradient optimization method is used to obtain good values of the multipliers.

IV. Numerical Experimentation

In order to test the effectiveness of the solution procedure we conduct several numerical experiments. The experiments are conducted using networks where number of nodes is 10, 15, 20, and 25 respectively. The networks are generated in such a fashion that each node has a degree equal to 2, 3, or 4 with probability of 0.6, 0.3, and 0.1 respectively. The network is assumed to be made of OC4 links and has capacity of 192 Mbps. We perform some experiments using different values of link capacities as well. After the generation of the networks, we generate the message tables. The total number of messages in the message table is dependant on the number of nodes of the network and is

equal to $k*N*(N-1)$, where k is the percentage of messages whose value is controlled by the network designer. For the base case, k is assumed to be 0.6. Hence, for the 10-node case, the total number of messages generated is equal to 54. We perform some experiments when the value of k is changed from 0.4 to 0.8 in steps of 0.1. The message table lists two types of messages and indicates the origin and the destination node for each node belonging to each class. The ratio of the number of messages belonging to lower priority to the higher priority is taken to be 80:20 in the base case. We perform experiments when the ratio of messages is changed to 90:10, 70:30, 60:40, and 50:50 as well. The messages belonging to the higher priority class are more demanding and the demand is assumed to be uniformly distributed between 30 Mbps and 40 Mbps. On the other hand, for messages belonging to the lower priority class the demand is uniformly distributed between 5 Mbps and 10 Mbps.

The revenue generated from the routing of the two classes of messages are also assumed to be uniformly distributed between [10,25] and [30,50] for the lower and the higher priority class respectively. The upper bound on the number of higher and lower priority messages on each link is taken to be 800 and 400 respectively. In our experiments we obtain the feasible solution, the gap between the feasible solution and the Lagrangean solution, the maximum and average utilization of the links, and the number of higher and lower priority messages that are routed over the network.

In the first set of experiments, depicted in Table 1, the experiments are conducted for networks where number of nodes is 10, 15, 20, and 25. The networks have a link capacity of 192 Mbps. The ratio of higher priority to lower priority message is 80:20. The demand for higher priority message is U[30,40] Mbps and the demand for lower priority message is U[5,10] Mbps. For this experiment, the percentage of messages (k) is increased in steps of 0.1 from 0.4 to 0.8. As k is increased the number of messages in each network increases. For example, for the 25 node case, when $k=0.8$, the total number of messages is 270. Of these 96 messages belong to the higher priority class and 384 messages belong to the lower priority class. From Table 1, we can observe the following. The feasible solution increases with the increase in k across all networks. The percentage gap remains reasonably low for all cases except when $k=0.8$. In those cases, the average utilization of the links increases a lot and there is not enough bandwidth to route all messages. It is also to be noted that for all cases where gap is greater than 5% the maximum utilization reaches 100%, which implies that for such a choice of k , at least one bottleneck link is obtained for the network. Since the messages belonging to the higher priority class has preemptive priority over messages belonging to the lower priority class, the algorithm preferably routes higher priority messages. Hence, we note that for high values of k , greater number of lower priority messages is dropped compared to higher priority messages, though higher priority messages are more demand intensive.

Traffic ratio	Feasible solution	Percent. gap	Maximum utilization	Average utilization	Routed calls for priority 1	Total calls for priority 1	Routed calls for priority 2	Total calls for priority 2
10 node								
90:10	1070.93	1.13	86.46	38.47	49	49	5	5
80:20	1164.87	1.05	100	45.73	43	43	11	11
70:30	1377.88	1.82	100	61.56	37	38	16	16
60:40	1329.4	4.89	97.92	73.75	30	32	21	22
50:50	1401.66	7.51	100	72.60	23	27	26	27
15 node								
90:10	2447.80	2.43	98.96	56.71	109	113	13	13
80:20	2712.57	1.73	100	74.10	99	101	25	25
70:30	2791.65	9.79	100	79.13	71	88	38	38
60:40	2732.05	16.73	100	81.31	62	76	42	50
50:50	2862.03	21.55	100	84.10	43	63	53	63
20 node								
90:10	4387.67	1.96	98.44	47.36	199	205	23	23
80:20	4853.35	4.81	98.96	58.64	170	182	46	46
70:30	5050.04	7.58	99.48	64.89	138	160	68	68
60:40	5001.76	16.84	100	71.97	98	137	85	91
50:50	5418.40	19.81	100	76.28	85	114	97	114
25 node								
90:10	7251.48	0.19	94.79	41.78	324	324	36	36
80:20	7663.60	1.74	100	44.36	280	288	72	72
70:30	8187.08	3.45	98.96	56.37	234	252	108	108
60:40	8626.35	5.29	99.48	65.10	188	216	143	144
50:50	9038.43	9.12	100	71.04	157	180	165	180

Table 2: Impact of ratio of low to high priority traffic

The impact of capacity of links on the generated solution is reported in Table 3. Our prior experiments assumed that all links in the network have a capacity equal to 192 Mbps which corresponds to an OC4 link. Next, we experimented with two more link capacities – 96 Mbps which represents OC2 links and 500 Mbps which represents OC9 links. Table 3 clearly shows that OC2 link is not suitable for our choice of problem parameters which are kept exactly same as the

earlier two experiments and with $k=0.6$ and ratio of low to high priority traffic fixed at 80:20. Our solution technique fails to generate high quality solutions for a link capacity of 96 Mbps and this leads to a large number of dropped messages. Between 192 Mbps and 500 Mbps it seems that the choice of OC9 links is overkill. When the link capacity is 500 Mbps, the average utilization remains less than 20%, which implies that a large amount of bandwidth is wasted.

Capacity	Feasible solution	Percent. gap	Maximum utilization	Average utilization	Routed calls for priority 1	Total calls for priority 1	Routed calls for priority 2	Total calls for priority 2
10 node								
96	972.55	21.11	100	67.08	37	43	8	11
192	1164.87	1.05	100	45.73	43	43	11	11
500	1164.96	1.04	41.20	17.67	43	43	11	11
15 node								
96	2147.13	28.94	98.96	69.73	80	101	16	25
192	2712.57	1.73	100	74.10	99	101	25	25
500	2736.83	0.49	48	19.29	101	101	25	25
20 node								
96	3423.32	47.76	98.96	59.07	107	182	36	46
192	4853.35	4.81	98.96	58.64	170	182	46	46
500	5046.42	0.251	50	16.13	182	182	46	46
25 node								
96	5181.45	50.20	100	61.23	172	288	49	72
192	7663.60	1.74	100	44.36	280	288	72	72
500	7770.06	0.16	90.4	17.98	288	288	72	72

Table 3: Impact of capacity of links

V. Conclusion

In this paper we provide an integer programming based formulation for the bandwidth packing problem with two priority classes. Since the problem is NP-complete, we use a Lagrangean relaxation based heuristic for solving this problem. We solve it numerically using networks of different sizes. Several experiments are conducted to check the impact of percentage of messages, ratio of low to high priority traffic, and capacity of links on the solution and the algorithm is able to generate high quality solutions under different situations. The experiments show how various factors affect the generated revenue and the routing of messages.

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Micro-Commoditization and Pay-As-You-Consume (PAYC) Model for Digital Entertainment Products – An Application

Kirtiraj Mohanty Pratap .K.J. Mohapatra
Department of Industrial Engineering and Management,
Indian Institute of Technology, Kharagpur – 721302 INDIA.
Telephone: 091-3222-283738 Fax: 091-3222-282272
Email: kr.mohanty@gmail.com and pratap@hijli.iitkgp.ernet.in

Abstract: The new technological developments and business strategies hold considerable promise to eradicate market inefficiencies and unravel a new era of digital commerce. Micro-commoditization and micro-consumption are the two new economic forces in motion, in the world of e-Business. With the advent of electronic commerce there is a shift from the traditional Pay First-Consume Next model (PFCN) and Consume-First-Pay Next model (CFPN) to a Pay-As-You-Consume model (PAYC) configuration. Among the various genre of microproducts, digital microproducts, such as music, movies, news, information items, and video games have a huge industry.

The present work incorporates the concepts of micro-consumption, micro-commoditization and the PAYC model in a web-application named *On-Demand-Music*. The PAYC model enables automatic reduction of balance from the customer's bank account, making the payment process fast and easy. The application enables users to consume digital microproducts (here music) in small granules rather than buying huge bulk of music (e.g. buying an entire CD containing only one or few favorite song(s)).

The Software Development Life Cycle (SDLC) approach has been used to analyze, design, code and test the web-application. Developed using technologies such as Java Server PagesTM (JSP), MySql and various Java plug-ins, the application enables users to listen to their favorite song(s) or parts of chosen song directly from the server.

The usefulness of present work is that it makes the mode of payment easier and brings out the essence of micro-consumption, micro-commoditization and the PAYC model in *music* as an example of digital entertainment microproducts.

Keywords: Case Study in E-Business, micro commoditization, micro-consumption.

I. Introduction

Commerce on the Internet

Electronic Commerce (e-commerce) is a general concept covering any form of business transaction or information exchange executed using information and communication technologies. It takes place between companies, between companies and their customers, or between companies and

public administration.

Electronic Commerce includes electronic trading and goods, services and electronic materials.

Commerce on the Internet is becoming ever more pervasive, reorienting traditional business practices with new strategies and operations. The Internet continues to create new consumer markets that never existed before, new players that position themselves between consumers and producers for efficient market transactions, and new technologies and market drivers that are redefining the processes of production and consumption in a market economy.

Microproducts- The future of Digital Economy.

Micro-commoditization and micro-consumption are the two new economic forces in motion, in the world of e-Business. [2] The producer is said to offer micro-commoditized products, if it disaggregates a product or service into small components and delivers it to consumers in a sequential manner. On the other hand, micro-consumption is the ability of the users to consume such products, to satisfy their on-demand needs. Such products are termed as Microproducts. These new concepts are likely to revolutionize the business practices, in the digital entertainment industry.

Micro-consumption and micro-commoditization have originated from the interaction of newer technologies, evolving global market structures and will be able to change the very concepts of supply and demand, for the future markets. Micro-commoditization is definitely more advantageous both for the buyer and seller as compared to bundling based pricing mechanisms, where buyers only pay for what they use, scarce resources are directed towards higher-valued consumers, and the markets reacts quickly in response to changing demand and consumption patterns. Enhanced resource allocation, dynamic pricing that speedily responds to changing supply demand patterns and the very essence of customization and interactivity are better experienced by consumers in microproducts.

Terms and Definitions

- “Micro-commodity: The ability of a producer to disaggregate a commodity into components of consumption at lower levels of component granularity.
- Micro-consumption: The ability of a user to consume the components at lower granularity levels over time.
- Customization: The ability of the seller to offer a

large menu of fine grained components, enabling customers to tailor their usage according to specific requirements. The shift from SPSU to MPSU modes of consumption.

- **Interactivity:** The ability of multiple users to consume a component concurrently, to enhance interactivity. The shift from SPSU to SPMU modes of consumption.
- **Trade-level contraction:** The shift from the traditional PFCN and CFPN practices to a PAYC configuration.
- The **customization effect** is a consequence of micro-commoditization of digital goods. The customization effect enables the seller to tailor offerings that fit customer requirements, dynamically package them, and deliver a suite of high-level services from a core set of micro-commoditized products.
- The **interactivity effect** arises from simultaneous micro-consumption by multiple users of micro-commoditized seller offerings.

The **trade-level contraction effect** is a natural consequence of the customization and interactivity effects. Trade-level contraction due to customization and interactivity results in short-term and as-needed market trades with natural shifts from traditional PFCN and CFPN to PAYC configuration. Fig 1.2 shows the projected impacts of Trade-level contraction Effects.” [2].

One of the emerging Micro-Markets

The emerging Digital Entertainment Products

Entertainment products, such as music, movies, news and information items, and video games, are intrinsically digital in nature. Generally the industry follows the Pay-First-Consume-Next (PFCN) mode of payment with pricing strategies such as subscription or bundling.

For example, music is sold in albums, which are a collection of songs related to a band or single artist. But since these products are digital in nature, the mode of selling these would change in future. Consumer are no longer inclined to buy music in large bundles as CDs or DVDs, because most items in those chunks may not have much of a consumption utility and hence the willingness to pay decreases. So micro-commoditization is the call of the hour.

Some Insight

“Interpreted in this way, the New or Digital Economy is about dynamics, not static efficiency. It is more about new activities and products than about higher productivity. What is really new in the New Economy is the proliferation of the use of the Internet, a new level and form of connectivity among multiple heterogeneous ideas and actors, giving rise to a vast new range of combinations. There are some measurable effects on productivity and efficiency, but the more important long-run effects are beyond measurement.

“A motivation for the development of microproducts and micropayments stems from the need to assure product quality. A long term subscription of bundled digital products

may be sufficient to guarantee quality based on the reputation of the seller. However, reputation has to be developed after repeated purchases. If sellers know, on the other hand, that the market will end soon-or they are short-run players-it is profitable to cheat by selling low-quality products at high-quality price. Knowing this, would consumers be willing to buy a product from unknown sellers? This problem is magnified if buyers are required to commit for a long-term subscription or to pay for a large bundle of unknown quality. Instead, recent research in contract theory offers some positive evidence that short-term sales may indeed produce higher quality than subscription and bundling. Short-term sales (some involving only one page of information) will be based on micropayments.” [1]

“Microproducts are simply pure digital products that become technologically and economically possible because of the low costs of modifying and distributing digital products in general. They allow consumers to try out products before paying for a long-term subscription or a large bundle.”[4]

The web-application named *On-Demand-Music*.

As seen from above discussion, digital music is an example of digital microproducts. So the web-application was developed with the following features:-

1. The Web-Based application provides a database of music, so that users can listen to their favorite music as and when they like without having to download the song file.
2. It employs the Pas-As-You-Consume (PAYC) model, where there will be automatic reduction of balance from the customer's bank account. So payment process will be fast and easy.
3. It enables the users to consume digital microproducts (here music), in small granules rather than buying huge bulk of music. (e.g. buying an entire CD containing only one or few favorite song(s))

II. The Sdlc Approach

The SDLC approach followed, simplified the analysis, design, coding and testing phase. So the application was developed, as a software project using the theories and principles of Software Engineering.

Purpose

The web-application provides a database of music, ubiquitously to Internet users and allows them to listen to it directly from the site rather than downloading the music file and then listening to it. It has many business advantages. Firstly, if a large number of users login, then the Website will earn very quickly. Secondly, it provides a database of music, so that users can listen to their favorite music, as and when the like and don't have to buy music CDs or store music files in valuable hard-disk space. Lastly, the Pay-as-you-consume (PAYC) model is being employed here, where there will be automatically reduction of balance from the customers' bank account. So the payment process is easy

and fast.

Scope

The application provides easy search and browse options to locate the songs which the user is willing to listen. It has connectivity with the bank's database to authenticate the users' credit card number and also to have the feature of e-payment where users' balance will automatically reduce.

The application also prompts a warning message when the user's balance goes to Rs.5 or less than Rs. 5. This feature ensures that no user can avail the service unless his/her balance in the bank is sufficient. The security aspect was given a lot of priority with lot of consideration done while coding.

General description

The product is perceived as a Web-site which will provide the netizens with unlimited music and will be played directly from the Web-site's server in the Web-browser. Any educated person with average knowledge of the Internet and basic computer skills can use the website.

Assumptions and Dependencies

- Users possess the basic know-how of computer and Internet usage.
- User understands simple English.
- The administrator of the web-application should be proficient in Java Server PagesTM, [3] Apache-Tomcat web-servers, and MySql- database server.

Use case Diagram

The figure below i.e. figure 1 shows the use case diagram and hence explains the way the user and administrator will interact with the web-application. It may be noted that, the use case diagram is more or less self explanatory. However, the user's and administrator's interactions with the web-application will be thoroughly dealt with, later. Also the <<extends>> feature has been used in the *Navigate/Search* use case with *search song* because another use case called *Browse category* is desirable in the web-application and should be added in the later stages.[see appendix].

III. Object Oriented Analysis

OOA consists of the partial static diagram (Figure 2), the Class responsibility collaboration (CRC) cards and the system sequence diagram. Such kind of analysis brings a thorough picture of the application to be developed. However, it is not necessary to discuss all these and present all these analysis in this paper.

Figure 2 show the partial static diagram of the web-application. In the diagram the *user* object initiates the *SearchASong* object, which is captured by the *WebApp* object. The *PlayList* is played by the *user*, which is updated by the *WebApp* and belongs to *AccountInfo*. The object *Bank* helps to determine *AccountInfo*. The various attributes of the

respective objects are shown below their names. Also the interaction of the objects are shown, where one object can interact with many objects.

IV. Object Oriented Design

Identification of the real classes is a very important job, before going forward in the design phase. From the partial static diagrams, a basic idea of what the classes will look like can be identified. The real classes are shown in Figure 3, in the next page. The classes are represented in the standard UML format, showing attribute and functions. For example, the class *PlayList* has No. of songs:int, Duration : double, rate : double as the attributes and play (song: Object): void as the only fuction.

Figure 4. shows the collaboration diagram of the web-application. Collaboration diagrams represent interactions between objects as a series of sequenced messages. Collaboration diagrams describe both the static structure and the dynamic behavior of a system. Various notes are show in the diagram, which are in fact self explanatory. This concludes the OOD and it is always advisable to go for coding only after completing the OOD. Also the OOD should be flexible to change later, as one follow a *spiral* model for software development life cycle.

V. Coding

The coding was done according to the analysis and design done previously. Although some new methodology and modifications were incorporated for convenience. It should be noted that, an object oriented language such as JAVATM was chosen to build the application as the analysis were done in the object oriented framework. JAVATM with Java Server PagesTM as the scripting language was used, which is easy to deploy, platform independent and robust. As the spiral model was followed, while coding the OOD part was modified, as and when felt convenient to improve the system performance and make the development easier.

VI. Testing

Various tests were performed to ensure that the web application was working fine and also to locate bugs.

Working of the search option

Various keywords were typed in the search text field and the results were observed. It was observed that if the keyword was the part of the song title or the album's name, then it all the results were displayed. Otherwise no result was displayed.

Reduction of balance from the bank account of the user

As the music was played simultaneously the site earnings should increase, the user's amount should increase and his

balance from the bank should decrease. This was tested and was found to be correct.

User authentication

Various wrong information like invalid credit card number, account number and invalid email address were entered. Javascript and sql commands were used to in the code to authenticate the user's information.

Working of the music player.

The player was tested with various play lists to see if it works in various situations.

Security

Security tests were made by logging off the user and trying to access the search.jsp page ,home.jsp page etc. With the use of sessions class of jsp the security was achieved where it will redirect the page to the login page if the user is not logged in.

VII. Conclusion

Summary

On-Demand-Music - the Web-application shows the application of micro-commoditization, micro-consumption and the PAYC Model. From this application a user only pays for what they consume and hence is the unique selling proposition of the service which they will avail. This web-application presents a business plan, which aims at delighting customers and also introduces to a market of on line digital media streaming, which is open without any major players. Hence that segment of the market is yet to be captured.

The web-application as developed with Java Server PagesTM and MySql database server is compatible with all platforms as JavaTM is platform independent. These technologies are latest and easy to deploy. Also the SDLC approach presents a clear picture of the various stages of analysis, design and development of the web-application as a software project. Also this web-application can be employed to generate raw data, and various data mining tools can be used to derive patterns and hence get to know what the customers wants.

Finally, this web-application as an example of digital entertainment products, shows a new business strategy which can be easily extended to other kinds of similar

products, such as, online newspapers, video streaming, online gaming etc. to name a few.

Scope for future work

On-Demand-Music – the Web-application being developed is just could be tested by the developer. Generally many new bugs appear when software is launched to be used by the users. So this web-application can be released as a beta version to know the bugs.

There are also a few things in the mp3 player which can be improved in future. The player doesn't have the seek option. Because of which consumers cannot drag to those part of the song which they want to listen directly.

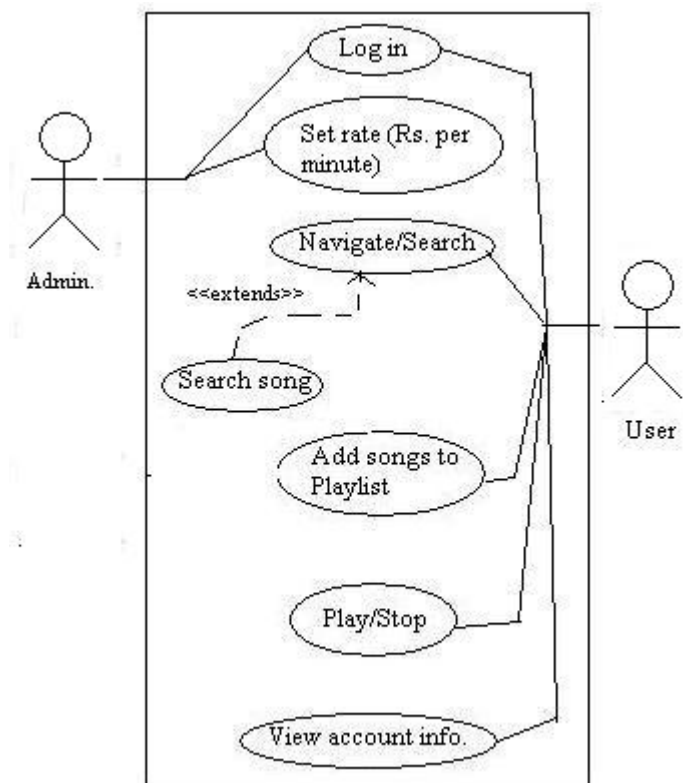
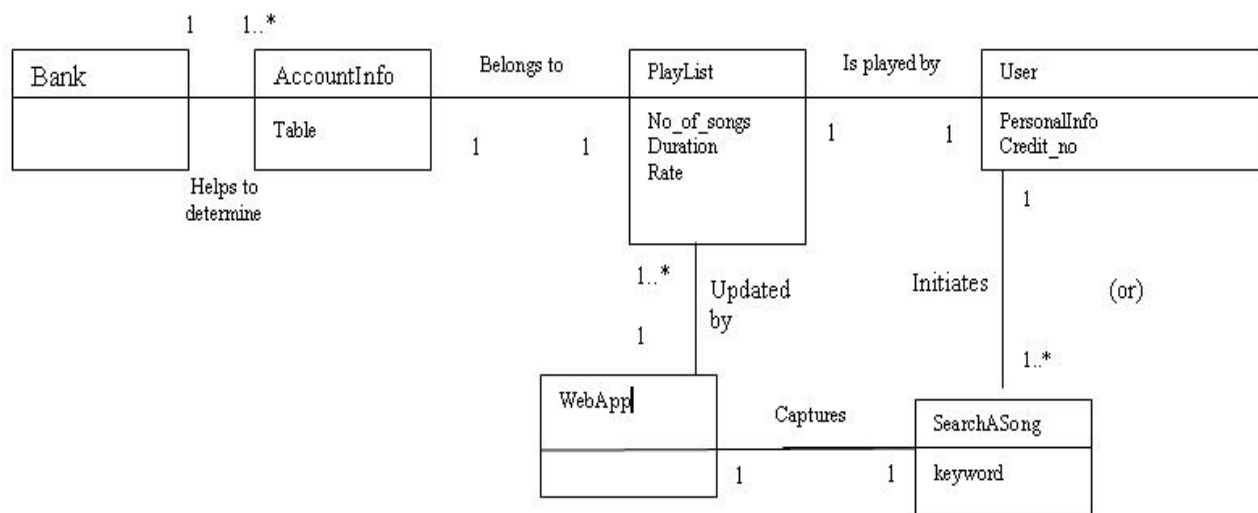
There is only the search option to search the songs which the user wants to listen. But there is no browse category option. This is important because sometimes user doesn't know the exact keyword to search for a particular song or album. So after a few attempts and continuously getting no results, the user might get frustrated and leave the website.

Also to populate the database, the administrator should be proficient with MySql server administration. But a separate Graphic User Environment or GUI can be developed specific to this web-application where it would be easier to manage the database as the database of songs will be huge if the application is launched for consumers.

Finally, there will be many legal and integration matters which will come as it is decided to launch this web-site. Matters like getting the rights from the producer of the music album, integrating the database connectivity with major credit card companies and banks etc. needs to be dealt with as they are few of the prime prerequisite before launching *On-Demand-Music* Web application.

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Figure 1. Use case diagram of *On-Demand-Music* web applicationFigure 2. Partial static diagram of *On-Demand-Music* Web application

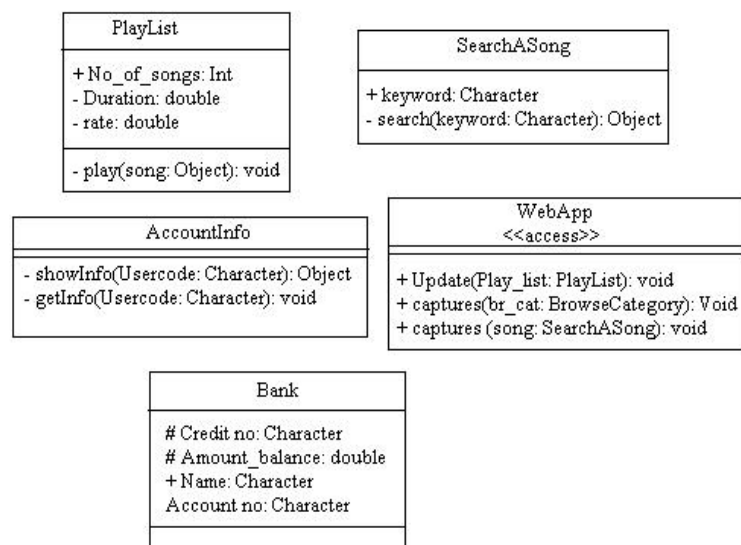
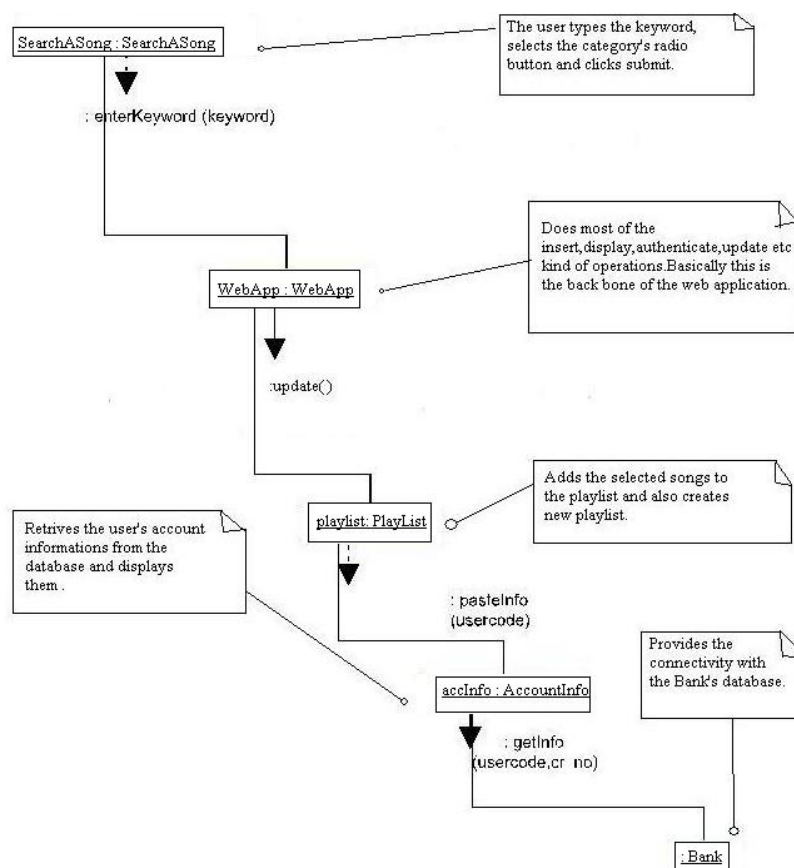


Figure 3. Real class identified for On-Demand-Music Web application

Figure 4. Collaboration diagram of *On-Demand-Music* Web application

APPENDIX

Screen shots of the various web-pages of *On-Demand-Music* - the Web-application.

The screenshot shows a web browser window titled "Get the online music experience - Microsoft Internet Explorer". The address bar displays "http://10.111.11.239/on-demand-music/login.jsp". The page content includes links for "Sign-up", "News", and "Help" at the top. Below these, the heading "On-Demand-Music" is followed by a description: "is an online application that enables users to listen to their favourite songs 24x7. We are committed to provide users with high quality and digitally superior music." To the right of this text is a login form with fields for "Username:" (containing "rohit") and "Password:" (masked with dots), and a "Sign In!" button. At the bottom right, there are links for "About Site", "Privacy", and "Terms".

Figure 5. Login page.

The screenshot shows a web browser window titled "Sign up @On-Demand-Music - Microsoft Internet Explorer". The address bar displays "http://10.111.11.239/on-demand-music/signup.jsp". The page content includes the heading "On-Demand-Music" and a "Sign up" section. This section contains a form with the following fields: "First Name:", "Last Name:", "Email Address:", "User Name:", "Password:", "Confirm Password:", "Gender:" (with radio buttons for "male" and "female"), "Credit card number:", and "Account number:". A "Submit" button is located below the "Account number" field. At the bottom left, a note states "Please provide valid information only."

Figure 6. Sign up page.

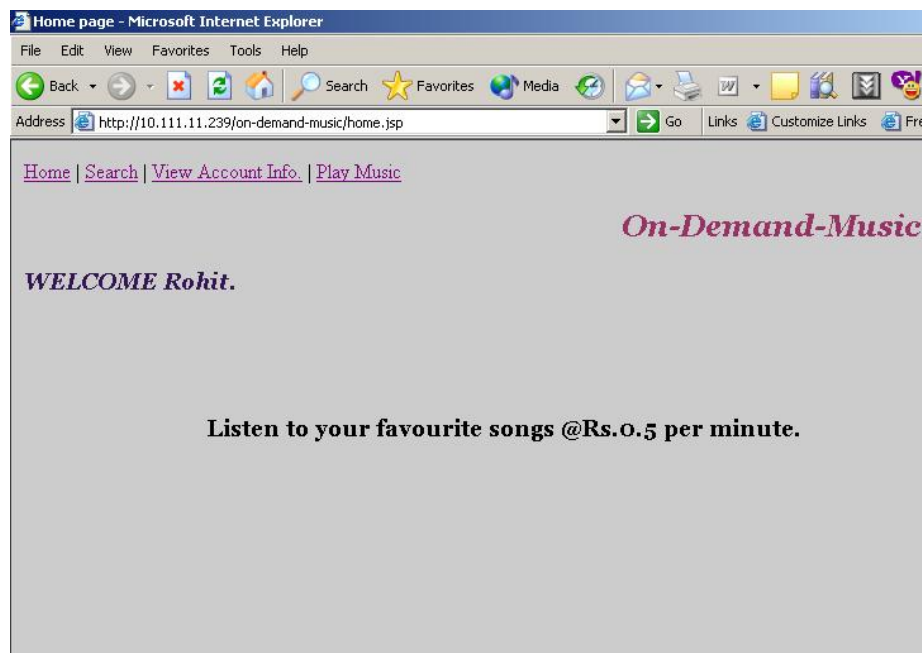
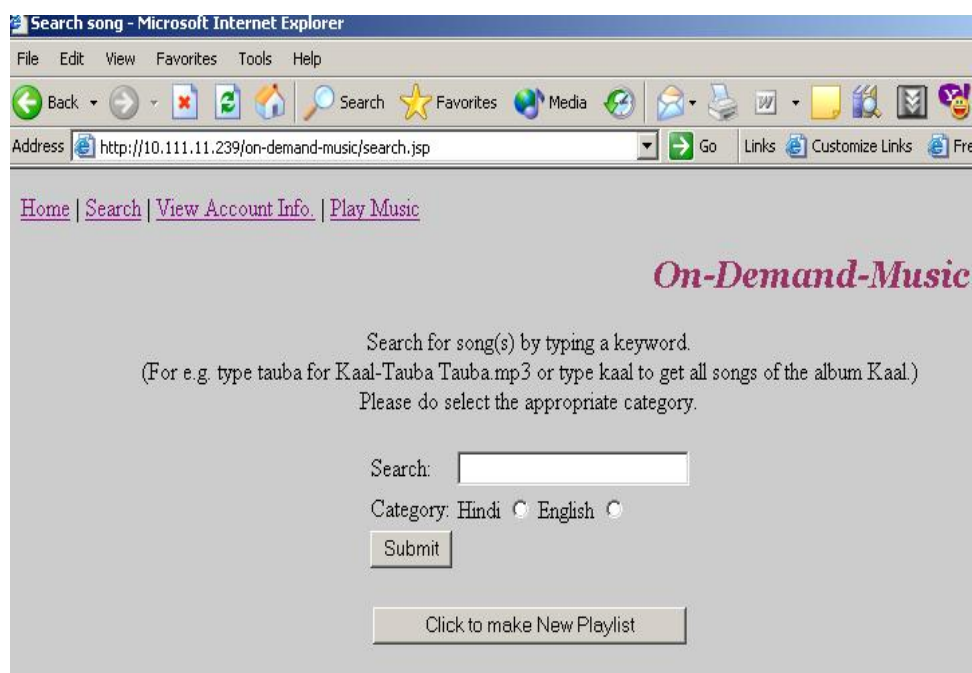
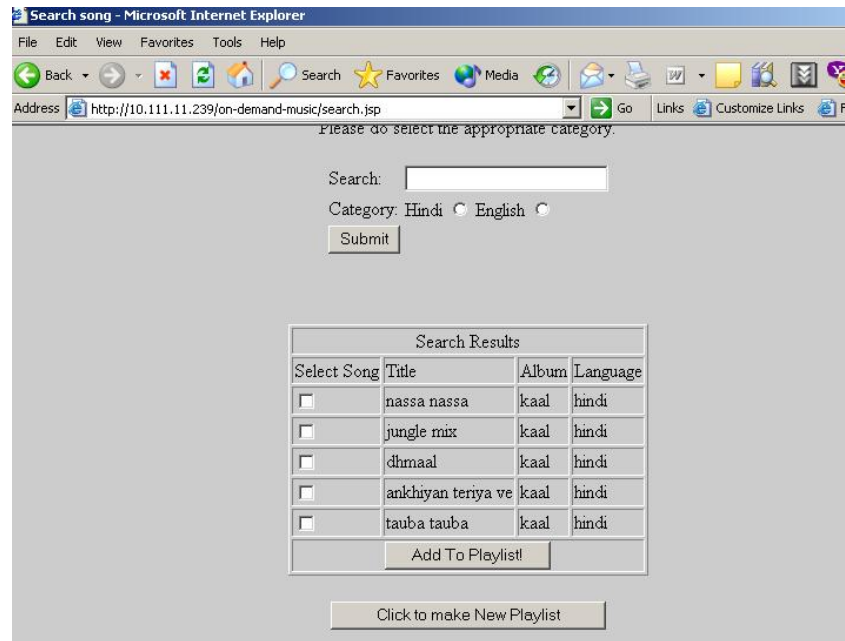


Figure 7. Home page.



(a)



(b)

Figure 8(a) Search page before searching
 Figure 8(b) Search page after getting some search results.

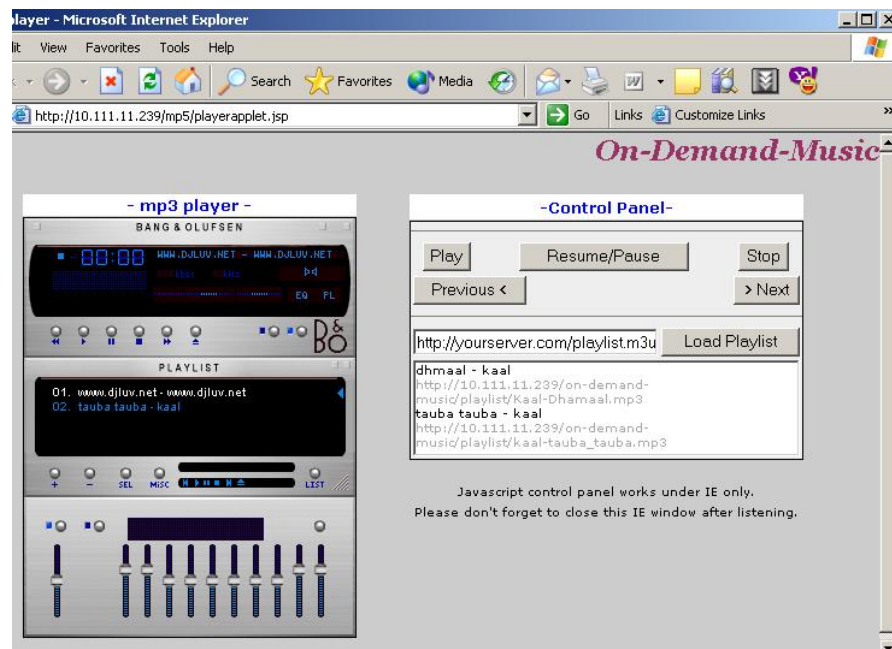


Figure 9 Player applet page with the control panel.

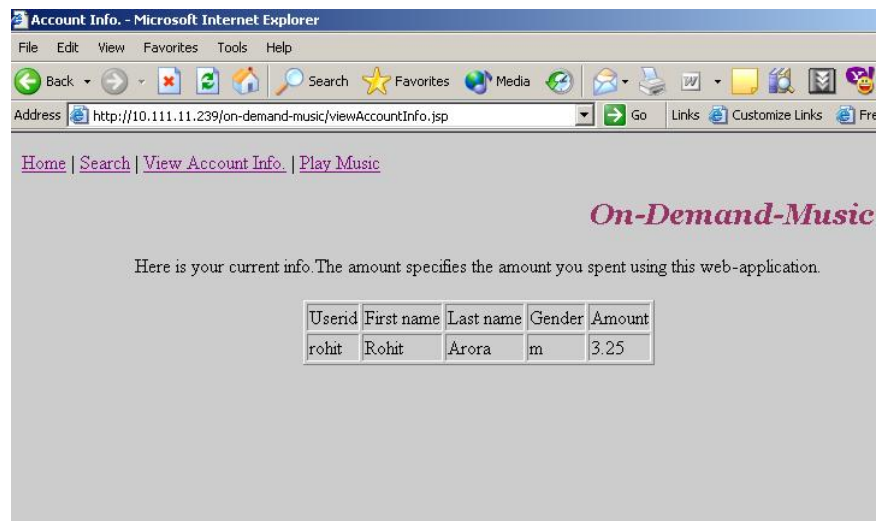


Figure 10. View account information page.

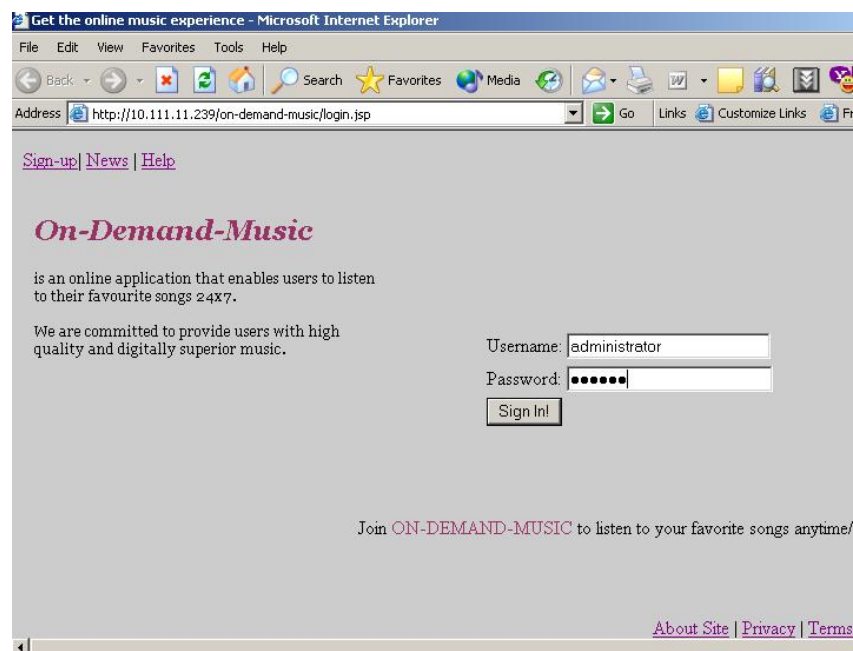


Figure 11. Admin login page

Figure 12 shows the Administrator's page where he can set the Rate/minute offered to users and can also see the site's total earnings.

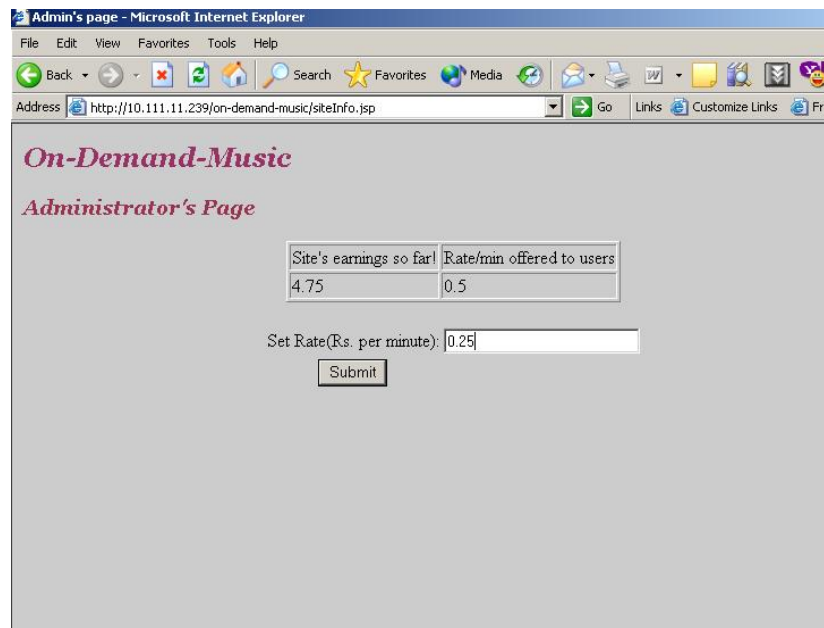


Figure 12 Administrator's page.

Causes and Effects of Online Industry M&A between International Internet Giants and Local Companies—Evidence from China

Bin Qiu¹ Shaoqin Sun² Cunyan Fan³, Shujen Chen⁴

¹School of Economics and Management, Southeast University, Nanjing, 210096, China
binqiu@tom.com

²Dept. of Economics and Trade, Nanjing Information Engineering University, Nanjing, 210044, China
shaoqinsun@yahoo.com.cn

³Netease Company, Guangzhou, 510665, China
hivans@sina.com

⁴California State University, Fullerton, U.S.A.
Schen@exchange.fullerton.edu

Abstract: This paper aims at identifying the inside reasons of M&A(Merger and Acquisition) of online industry in China between international Internet giants and local companies and exploring the basis on which online industry can develop steadily and thus have a successful and sustainable business model. In the meanwhile, a case study will be made by analyzing the causes of the merger of Yahoo China into Alibaba from the perspectives of both parties. Then, this paper points out the possible effects of this merger on China's online industry. In the end, some conclusions will be made on how to build up core competence in online industry in a unique business circumstance in China.

US Internet giant Yahoo ended its six years of independent operations in China since August 2005 and joined forces with Chinese leading e-commerce company Alibaba.com. Yahoo China will transfer all operations in China including an Internet portal, e-mail services, instant messaging, Internet search services and its keyword services to Alibaba as well as paying US\$1 billion for a 40 per cent stake in Alibaba. This Merger is not only a single commercial buying case but also a symbol for creation of new revenue model in China. [2]

Keywords: Case Study in E-Business; M&A; Online Industry; China.

I. Characteristics of Online Business in China and Stages in M&A of Online Industry over the Past 5 Years

I. 1 Characteristics of Online Business in China

With an online population of nearly 100 million, China's internet infrastructure is developing very fast, and China has surpassed Japan and become the second largest country in its Netizen number next to US [1]. However, due to its unique cultural and political environment, the development of online business in China seems to have had no breakthroughs since 2000 after the Dot-coms gradually lost their wizards. For example, because of the lack of credit system and strict regulations in China, the online business is

still at an early stage according to the turnover of online transactions.

However, the potential in online business in China can NOT be overlooked. According to a recent survey by IDC, the online population of China will surpass U.S. in 2010, and new killer applications including search engine, online games, instant messaging and internet phone calls will develop very fast in China due to its large scale of online population. Thus, a smart company can easily find the expanding potential in China and the cooperation between Yahoo and Alibaba is the best evidence showing the confidence in Chinese online business market.

I. 2 Stages in M&A of Online Industry over the Past Years

Looking back to the M&A cases in China in the past 7-8 years, it is not difficult to find that the merger and acquisition has experienced the following three stages:

● Stage 1(1998-2000)

Since it is the inception of development of online business in China, the business model was very simple at that time and the Internet portal dominated in online industry and the ad revenue is the main source of the income for most of the online companies. With the demonstration effect of the case that AOL.com merged Time-Warner, one of the characteristics of M&A at that time is that the merger occurred between an online company and a company dealing with traditional businesses, and the buyer in most cases was an online company especially an Internet portal.

● Stage 2(2001-2003)

After the Internet bubbles got broken in 2000, overnight wealth was no longer the dream of most online companies. They began to search for the business model that can be really materialized. During this period of time, the M&A was technology-oriented and online companies hope that they can earn money with the help of new technologies like search technology, instant messaging, online gaming, and so on. A good example is that Yahoo China acquired 3721 for US\$ 120 million with 3721 founder Zhou Hongyi becoming President of Yahoo China.

● Stage 3(2004-present)

In real operations, the international companies including Yahoo have no obvious advantages over the local competitors like Sohu, Sina and Netease. It is partially due to the fact that even a local company in China can easily copy the business model of a U.S. company let alone its advantages in knowing local factors well. For example, Yahoo China never won in its competition with its Chinese competitors in traditional businesses like e-mail services, online advertisement, etc. The merger between Yahoo China and Alibaba is a trial of cooperation other than a zero sum game.

II. Causes of Current M&A Between International Internet Giants and Chinese Companies

(1) Good Economic Outlook and Improvements in Internet Infrastructure in China

China's rapid growth in Internet users, rising disposable income, low Internet penetration, a huge population of mobile phone users and growing e-commerce has put the country front and center on the radar of most of the world's Internet companies. Western Internet businesses' eager to tap its growth has been expanding their investments.

(2) Cultural Differences and Complex Regulations on Internet Industry

As mentioned above, though China has the second largest online population in the world, the online transactions are still very limited due to its lack of credit system and its unique consumer behavior features. For example, online payment system is not easy to put into use because most consumers are unwilling to pay online and thus select a COD (Cash on Delivery) model. Another reason is that the Chinese Government has lots of regulations on Internet industry and are reluctant to let a foreign company control the country's top Internet portals and other kinds of Internet companies. Under these circumstances, it is the best way for the international Internet giants to get quick access to local market by forming strategic partnership instead of acquiring top Chinese portals directly.

(3) Getting Complementary Advantages for Both Parties

The international Internet giants and the local Chinese companies have their respective advantages and disadvantages. The international Internet giants have advantages in their capital assets, experience in going public on stock market and state-of-the-art technologies in Internet. While in the meantime, the local Chinese companies are better in their connections with governments at all levels, marketing channels and first-mover advantages as well as their inherent cultural similarities.

III. Case Study –The Strategic Partnership Between Yahoo! and Alibaba

III. 1 Corporate Overview of Alibaba.com

Alibaba was founded in 1999 and is based in Hangzhou, eastern China. It has over 2,000 employees, 13 regional sales offices across China and other offices in Hong Kong, Silicon Valley, Europe, and Beijing. Alibaba.com is China's leading e-commerce company, operating the world's largest online marketplaces for both international and domestic trade, as well as China's most popular online payment system, AliPay. The Alibaba websites have more than 15 million registered users in 200 countries and territories. In 2004, over US\$4 billion in trade is estimated to have come from buyers and sellers connecting at Alibaba sites. [4]

III. 2 Causes of Forming Strategic Partnership from the Perspective of Yahoo

(1) Yahoo has NOT been so successful in Mainland China

The US giant, which set up its Chinese operation in 1999, has been dogged by frequent personnel changes and twists in company strategies. Its first China general manager stayed at the post for only one year. Operations on the Chinese mainland were then overseen by executives in Hong Kong and Taiwan and the focus was still on online advertising which makes them face cooling ad revenue. Compared to other famous local Big Three portals, Yahoo's ad revenue in China in the year 2004 is very limited see Figure 1, amounting to only 50 million RMB Yuan. [5]

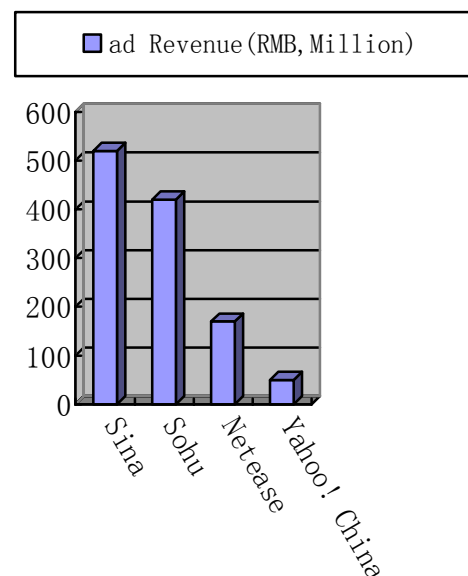


Figure 1. Ad Revenue Comparisons Between Yahoo! China and Big Three Local Portals

(2) Yahoo May Obtain Complementary Advantages from Alibaba

Since Alibaba is the most comprehensive website with its areas in e-commerce, business to business, customer to customer, payment system and an auction site, Yahoo may obtain the above-mentioned complementarities by forming strategic partnership with Alibaba very easily.

(3) Yahoo China Can Fulfill Its Strategic Shift from an Operator to an Investor

The merger of Yahoo China into Alibaba has made it become a local company instead of the branch of a U.S. company. The shift from an operator to an investor has greatly simplified its business in China.

III. 3 Causes of Forming Strategic Partnership from the Perspective of Alibaba

(1) Alibaba May Obtain Search Engine and E-mail Service Technology

As the biggest business-to-business website in the world, Alibaba is in urgent need of mature search technology and e-mail services for its 8 million customers all over the world. Yahoo's such expertise will greatly facilitate the searching efficiency for Alibaba customers.

(2) Removing the Obstacles for Alibaba to be Listed on the Stock Market

The business-to-business model that Alibaba adopted is no longer fresh to investors in international stock market. And Alibaba's auction site Taobao.com still lacks of enough revenue that can attract the investment from Wall Street. The partnership between Yahoo and Alibaba at least made Alibaba the most comprehensive website consisting of almost all the business models including BtoB, BtoC and CtoC. In addition, with an international Internet giant as its shareholders, it will win the Chinese company a worldwide reputation. [3]

IV. Effects of the Strategic Partnership Formed Between Yahoo! and Alibaba on China's Online Industry

IV. 1 Creating a New Revenue Model

The Internet industry has been plunged into slump since the overnight rich dream broke 1998 through 1999, and China is no exception. The real reason for that is that no good business model has been developed. Although Yahoo! is a successful net company in the U.S., however, its performance in China is not as good as expected. This can be seen from the following several criterion. First, its ad revenue is far less than the Big Three portals; Second, its traffic can only rank 6th in China, next to some "small" companies; Last, Yahoo! China is a company whose business has no apparent differentiation advantages. While in the same time, Alibaba is a young company compared to Yahoo!, but it is the largest B2B website in China, especially deemed as the largest horizontal e-marketplace for importers

and exporters the world over. In an industry where searching technology is most important of all, Alibaba finds the strength of Yahoo! China's search engine at first glance, especially Yahoo! China has very powerful technology in searching for keywords in Chinese, and this helps a lot for a horizontal e-marketplace majoring in import and export business. Therefore, Alibaba is eager to enter into a strategic partnership with Yahoo! China because they have very strong complementary abilities. According to strategic alliance theory, the effect of strategic alliance will exist for a long time until the complementary abilities disappear (see Figure 2).

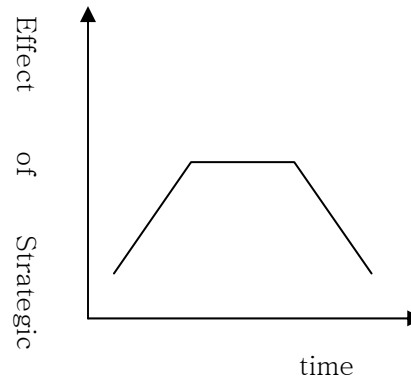


Figure 2 Effect of Strategic Alliance

IV. 2 Setting a Good Example for International Cooperation in Online Industry

In the past, seldom did international internet giants see real cooperation between local companies and them. They attributed this to policy barriers or discrimination. However, the successful alliance between Yahoo! China and Alibaba could be a symbol for gaining support from the Chinese government for real partnership. This merger can greatly reinforce the confidence for international institutional investors in IT field and set a good example for international cooperation in online industry.

IV. 3 Promoting Imports and Exports for Chinese Companies

After Yahoo! China was merged into Alibaba.com, Ma Yun, the CEO of Alibaba started to specialize the searching technology to support his customers in identifying both potential commodities and potential customers. In fact, since most of Alibaba's customers are dealing with import and export activities, the stronger searching technology will significantly strengthen the competitiveness of Alibaba and therefore promote the export activities for Chinese manufacturers and the procurement of international buyers.

V. Conclusions

Even in online industry, the companies should abide by laws and principles that are frequently used in traditional

industries such as the power of strategic alliance, cost advantages and so on. In other words, the traditional economic rules can also be well embodied in online industry.

The partnership between Yahoo and Alibaba has announced the failure of traditional business model in online industry. The Internet portals can only realize its value through the combination with the “real” business like what Alibaba is dealing with.

The partnership between international Internet giants and local companies of China has also shown the strengths from both capital and market. The international Internet giants represent the power of capital while the local companies of China represent the power of the market. The partnership aiming at obtaining both strengths is a completely ideal combination and will probably result in a great success.

Acknowledgement

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Strategies for B2B Electronic Markets: Delivering Business Value to Buyers and Sellers

Chia Yao Lee

School of Information Systems, Deakin University, Melbourne, Australia
chia.lee@deakin.edu.au

Abstract: This paper discusses the key elements of effective and successful strategies for organisations engaging in Business-to-Business (B2B) Electronic Markets. Existing literature have concentrated on developing schemas for categorising B2B Electronic Markets, and evaluating the innovative business models they employ, with less focus on understanding the business value of B2B Electronic Markets from a multi-stakeholder, business strategy perspective. In the present business climate, business managers and executives are keen to discover strategies to maximise performance improvements associated with ICT adoption. Based on case studies of B2B Electronic Markets, this paper discusses the importance of (i) creating and distributing business value among the various stakeholders, (ii) determining a pragmatic approach for engaging in B2B Electronic Markets, and (iii) managing the transformation of business processes associated with B2B Electronic Markets. The study contributes to practice and research by presenting rich empirical insights into the operations of B2B Electronic Markets, and providing suggestions for future research in the topic area.

Keywords: Case Study in E-business; Electronic Markets; Business Value of IT; Business Strategies.

I. Introduction

Over the past two decades, B2B Electronic Markets have attracted substantial attention from practitioners and academic researchers, for they represent an economic model that promises to transform traditional ways of doing business, influencing organisational practice and the make-up of industries [2, 12, 13, 20]. Predictions have been rife that B2B Electronic Markets will quickly become a strategic necessity for organisations, and in turn become an important part of an industry's infrastructure [2]. In reality however, B2B Electronic Markets have had less profound effects. Several prominent B2B Electronic Markets that became the posterchild of the Dotcom era have fallen victim to acquisitions, mergers, or failed altogether [4], thus bringing into focus the problem first raised by Wise and Morrison [20] that *"The use of the Internet to facilitate commerce among companies promises vast benefits: dramatically reduced costs, greater access to buyers and sellers, improved marketplace liquidity, and a whole new array of efficient and flexible transaction methods. But if the benefits are clear, the path to achieving them is anything but."*

This paper addresses the important issue of how and why organisations derive business value from engaging in B2B Electronic Markets. The research question that underlies the study asks,

"What are the important elements that underpin effective and successful strategies for B2B Electronic Markets?"

The paper discusses the roles B2B Electronic Markets play in inter-organisational relationships, and highlights the need for developing a pragmatic approach for participating in B2B Electronic Markets. The inability of B2B Electronic Markets to focus on issues beyond transaction cost reduction has narrowed the prospects of many B2B Electronic Markets during the Dotcom period, and limited their ability to achieve long-term sustainability. The present study addresses a call in existing literature to regard the Internet and other relevant Information Technologies as a complement to, instead of a cannibal of, traditional ways of competing [16]. Highlight is also placed on effective management of the business process transformations that accompany B2B Electronic Market adoption [3, 11].

II. Literature Review

Research in B2B Electronic Markets draws on accumulated knowledge in economics, management, marketing, and information systems, due to the cross-disciplinary nature of B2B Electronic Markets, and the loci of the impact and implication of B2B Electronic Markets. Several theoretical frameworks from different research streams have been adapted and modified for studying B2B Electronic Markets. These theoretical frameworks include the Transaction Cost Theory [19], the Network Externality Theory [9], the Diffusion of Innovation Theory, and, Game Theory [18]. Individually, these frameworks are inadequate, and insufficient for explaining the richness of the B2B Electronic Markets phenomenon, nor the depth of its implication [1]. Amit and Zott [1] summarised that *"research on e-business and, more generally, on competition in highly networked markets, will benefit from an integrative approach that combines both strategy and entrepreneurship perspectives."* This paper addresses the above problem, by drawing from different theoretical approaches, and not being constrained by any particular theoretical framework. Using the resource-based view of the firm to develop a descriptive model of the value generating process, Melville et al. [14] defined IT Business Value research as *"any conceptual, theoretical,*

analytic, or empirical study that examines the organisational performance impacts of IT". Lee and Corbitt [10] proposed an analytical framework that uses Aggregation, Matching and Integration as the key sources of business value of B2B Electronic Markets.

Existing literature have concentrated on developing schemas for categorizing and classifying B2B Electronic Markets [8, 15, 16]. These schemas enable organisations to better understand the characteristics of various B2B Electronic Market models, and develop strategies to maximise the related business value [8]. Operators of B2B Electronic Markets reasoned that the adoption of ICT would improve communication and coordination among organisations, favouring a shift towards market-type structures for governing inter-organisational commerce. However, too much emphasis has been placed on the issue of reduced cost of transaction. This undermined opportunities to study the impact of B2B Electronic Markets on inter-organisational relationships and on complex inter-organisational business processes [3, 7, 11], independent of the implication of the Transaction Cost Theory.

The Game Theory [18] has been used to model participant behaviour and organisational strategies in B2B Electronic Markets [5, 21], by describing how participants will pursue strategies that will deliver optimal returns in a given environment. While it has been obvious that the ability to produce and sustain a Win-Win situation is an important factor that heralds the success of B2B Electronic Markets the issue at hand that is equally important is how do B2B Electronic Markets achieve this ability? Thus, practitioners and academic researchers are keen to understand strategies that lead to just and fair creation and distribution of business value among participants, in a B2B Electronic Market environment.

As Jap [6] and Kambil and Van Heck [7] have found, unless all major stakeholders are better-off, a B2B Electronic Market system is less likely to succeed. The Network Externality Theory [9] has also been used regularly for describing the rollout and adoption of B2B Electronic Markets. The central argument is that the more participants there are on the networked system, the greater the benefits an individual participant will gain, especially from interacting with the existing participants. Hence, logic would predict that for B2B Electronic Markets to succeed, they need to attain a critical mass, especially in the number of participants. In terms of economics of scope, this translates to a substantial range of business functionalities being facilitated.

Porter [16] considered B2B Electronic Markets from a competitive strategy perspective. He surmised that, bar some fragmented industries, if B2B Electronic Markets do not provide additional value to buyers and sellers, as an intermediary, B2B Electronic Markets may find themselves disintermediated if buyers and sellers transact directly.

In [3, 7, 11, 20], it was found that substantial benefits from engaging in B2B Electronic Markets lie in an organization's ability to automate internal and external

business processes, and subsequently integrate the automated processes across organisational boundaries. The transformation of business processes produces organisation-wide impact, thus, presenting opportunities for organisations to streamline complex procedures, especially those that require frequent human intervention. The transformation of business processes requires delicate management, due to the diversity of the stakeholders involved, and the complexity of the transformations. In addition, the potential for uneven creation, distribution and capture of the business value may adversely influence the participation by stakeholders.

There is little doubt that the value propositions presented by B2B Electronic Markets continue to evolve and shape organisational strategies. Issues which have arisen from recent studies suggest that managing the transformation of business processes, and the ability to adapt business strategies to extract value from the transformations, may hold the important elements to effective and successful B2B Electronic Markets strategies.

Building on prior work in B2B Electronic Markets [2, 3, 6, 8, 13, 16], this study explores the following issues in detail:

- (1) the creation, distribution and capture of business value amongst stakeholders;
- (2) the determination of a pragmatic approach for engaging in B2B Electronic Markets; and
- (3) the management of B2B Electronic Markets-enabled process transformation.

III. Methodology

This paper describes part of a comprehensive exploratory study into the strategic sources of business value of B2B Electronic Markets. Six case studies of B2B Electronic Markets were conducted. The study adopts a qualitative approach to gain a deep insight into these case study organisations [15]. The typology of B2B Electronic Markets involved ranges from Private Electronic Markets used for procurement and distribution purposes, to Independent Electronic Markets that provide one-stop buying and selling solutions for organisations. Semi-structured interviews were conducted with 16 executives who were actively involved in the operations and implementation of the B2B Electronic Markets. The hermeneutic process [15] was employed for analysing and synthesising data collected. A summary of the six cases is illustrated in Table 1.

Table 1. Summary of Case Studies

	Description	Market Ownership model	Business functionality facilitated
Case 1	Reverse Auction site	Privately operated by the buyer	Sourcing, Procurement, Price Determination
Case 2	Life science Electronic Market	Independent, 3 rd party market-maker	Information exchange, Marketing, Sourcing, Ordering
Case 3	Steel Electronic Market	Independent 3 rd party market-maker	Information exchange, Auctions, Sourcing, Procurement, Ordering, Insurance & Transportation.
Case 4	Electronic Distribution Channel	Privately operated by the supplier	Inventory management, Information exchange
Case 5	Indirect supplies Electronic Market	Privately operated by a buyer, but backed by a consortia	Catalogue, Auctions, Sourcing, Ordering
Case 6	Healthcare Supplies Online Catalogue	Privately operated by a supplier-cum-intermediary	Access to pricing and inventory information, Catalogue, Ordering

IV. Research Findings

The six B2B Electronic Markets studied can be broadly categorised into (a) Private, and (b) Independent B2B Electronic Markets. Private B2B Electronic Markets are typically established, operated, and financially-backed by a focal organisation, which plays the primary role of a market-maker. The market-maker has substantial influence in the market segment, and is a prominent member of the supply chain community, such as an Original Equipment Manufacturer (OEM), a retail chain, or an assembler of products. As the name suggests, participation in Private B2B Electronic Markets is restricted to the trading partners of the market-maker. Usually, Private B2B Electronic Markets are implemented to address a specific need of the market-maker, e.g. procurement or sales.

In contrast, the market-makers in the case of Independent B2B Electronic Markets are typically neutral third parties. The market-makers do not have a direct stake in the transaction, they are neither a buyer nor a seller. Participation in Independent B2B Electronic Markets is open to a variety of organisations, depending on the structure of the Electronic Market – vertical or horizontal. Cross-case analysis of the case study data suggests that the business

strategies adopted by the market-makers, the buyers and the sellers, vary considerably, depending on the market ownership model used.

Strategies for Private B2B Electronic Markets

In analysing the business strategies deployed by market-makers, buyers and sellers, it was observed that the creation, distribution and capture of business value among stakeholders in Private B2B Electronic Markets are more likely to be uneven, with the market-makers emerging as the main beneficiaries. By channelling a substantial portion of their existing business via Private B2B Electronic Markets, the market-makers have consolidated their existing channels for sales and procurement, eliminating inefficient and ineffective processes and practices. For example, the market-maker in Case 1 had developed the Private B2B Electronic Market for sourcing and procurement purposes. Adoption of the Private B2B Electronic Market enabled the market-maker to benefit from economies of scale, by aggregating its internal purchases, and negotiating bulk discounts with suppliers. The market-maker organisation also experienced economies of scope benefits through reusing the same Private B2B Electronic Market for sourcing a variety of supplies. As noted by an executive in Case 5, the adoption of Private B2B Electronic Market for procurement reduces maverick purchases. Employees are less likely to place deals with non-preferred suppliers, or miss out on existing deals negotiated with the preferred suppliers.

From the perspective of buyers and sellers, the adoption of Private B2B Electronic Markets is political, and viewed with a degree of scepticism. Some small buyers and sellers viewed participation in Private B2B Electronic Markets as a pre-requisite for trading with large organisations. The participation issue becomes a strategic necessity for the small organisation, rather than a competitive advantage. However, large organisations which have participated in Private B2B Electronic Markets established by their major suppliers or customers have also attempted to avoid, or bypass the Private B2B Electronic Market. For example, a major supplier in Case 1 had commented that they were willing to match and better an offer listed in the Private B2B Electronic Market, but unwilling to place a counter-offer to the bid listed. The supplier perceived making pricing and inventory information available to competitors and customers as a loss of competitive advantage. Also in Case 1, a supplier which had secured a contract tendered on the Private B2B Electronic Market negotiated with the market-maker to extend the duration of the relationship. The supplier argued that they wished to increase business certainty in the medium term while saving themselves the trouble of having to renegotiate new supply contracts online regularly.

The issue of uneven creation, distribution and capture of business value among stakeholders is more of a concern among participants of Private B2B Electronic Markets, due to the biased orientation of the trading environment. While the smaller-sized buyer and seller may benefit from gaining

access to trade with a major supplier or customer the additional resources required in planning, managing, and transforming their internal business processes to accommodate Private B2B Electronic Markets are often overlooked, or underestimated. In addition, market-makers need to consider the suitability of Private B2B Electronic Markets on a case-by-case basis, taking into account the attributes of the product, the existing relationships with trading partners, the economic climate, and a host of other ancillary factors, to ensure the outcome is optimal.

Strategies for Independent B2B Electronic Markets

Past studies indicated that the sustainability and success of Independent B2B Electronic Markets rely on a number of factors, such as the volume of transaction processed, the type and range of business processes supported, and the number and diversity of the participating organisations [8, 20]. Like Private B2B Electronic Markets, Independent B2B Electronic Markets rely on the market-maker to generate the required volume of transaction and attract the right mix of participants albeit without the backing of a major supplier, manufacturer or customer.

The Independent B2B Electronic Markets studied have had to fend off competition from other B2B Electronic Markets. The market-makers are constantly motivated to present a unique set of value propositions to their clients that cannot be easily replicated by competitors. At the same time, the market-makers have to employ strategies to attract the right crowd, the right mix of buyers and sellers to the independent trading environment, while maintaining a reliable and sustainable business model. Independent B2B Electronic Markets thrive in highly fragmented market segments whereby buyers and sellers could quickly and inexpensively extend their reach, and expand their capabilities to trade with a greater pool of trading partners. Data from Case 2 suggested that the market-maker diversified its revenue stream by branching into print publication and advertisements to supplement revenue collected from membership and transaction fees from the electronic market.

The market-maker in Case 3 sought to expand the scope of business functionality supported by becoming a one-stop shop for buyers and sellers. It provided a range of value-added services, such as payment processing, product inspection, and logistics through its allied partners. The underlying rationale is that by expanding the scope of business functionality supported, it provides additional revenue streams and presents a set desirable value propositions to its clients. Many B2B Electronic Markets, both Private and Independent, have pursued this path, by morphing their intermediary and brokerage model into a one-stop solutions provider model.

From the perspective of buyers and sellers, Independent B2B Electronic Markets were employed as a low-cost channel for spot transactions, e.g. unplanned purchase of out-of-service equipments, or for getting rid of surplus inventory. Buyers and sellers also used the Independent B2B

Electronic Markets to smoothen out spikes and shocks in demand and supply cycles. Although market-makers have concentrated on providing a extensive scope of functionality, it was observed that the participating organisations seldom utilise all of the value-added services. Participants of the Independent B2B Electronic Markets engage in these trading systems for a specific purpose, such as accessing new trading partners in a highly fragmented market to quickly accessing vendors of urgently required items or to inexpensively dispose of excess inventory. The increasing number of organisations that utilise eBayBusiness.com, a B2B-centered eBay, for similar purposes confirms this empirical finding.

The issue of uneven creation, distribution, and capture of business value is less of a concern to buyers and sellers in Independent B2B Electronic Markets. Challenges remain however, for the Independent B2B Electronic Market to fend off competition by rival B2B Electronic Markets, and the threat of disintermediation by direct interaction between buyers and sellers. The other challenge for Independent B2B Electronic Markets lies in their ability to attract and maintain the right mix of buyers and sellers. While healthy competition among the participants is encouraged, intense price competition quickly erode the competitive capability of participants, and overly-friendly inter-organisational relationships may lead to collusion.

Table 2 summarises the important elements of the business strategies employed by buyers, sellers, and market-makers for participating in B2B Electronic Markets.

B2B Electronic Markets and the Transformation of Business Processes

Data from the six case studies indicated that the transformation of business processes due to the implementation of B2B Electronic Markets is an issue that all parties have to address. The difficulty in quantifying the business value of B2B Electronic Markets, is likely related to the challenges that lie in understanding the transformation of business processes due to B2B Electronic Markets.

Kambil and Van Heck [7] posited that using a stakeholder-process framework enables one to better understand how and why an Electronic Market system transforms business processes, and thus delivers value to the different stakeholders.

In this study, a similar approach was adopted, and the adoption and implementation of B2B Electronic Markets were evaluated by identifying the business processes they transformed, from the perspective of the stakeholders they impacted. It was found that additional incentives were required, such as collaborative sharing of inventory information, and sometimes in the form of additional monetary assistance, to encourage trading partners and customers in particular to participate in B2B Electronic Markets. The reduction of transaction cost alone is insufficient as an incentive.

The results indicated that a pragmatic approach is crucial

for the success of B2B Electronic Markets, especially from the perspective of the market-maker. The B2B Electronic Market model adopted must be clearly defined and the business functionalities and processes supported have to be fully understood. This is to ensure that the limitations of the

B2B Electronic Markets are known in advance, and the market-makers do not have a mentality that “if we build it, they will come.”

Cost reduction is of particular concern for many organisations. The question they face is whether they are

Table 2: Stakeholder Strategies in B2B Electronic Markets

	Private Electronic Markets	Independent Electronic Markets
Strategies for Market-maker/Operator	<ul style="list-style-type: none"> (i) Channel a substantial proportion of existing transactions through the Private Market. (ii) Avoid confrontational style in encouraging trading partners to engage in Private markets. (iii) Strategies to redistribute business value are especially important, due to the uneven creation and capture of business value. 	<ul style="list-style-type: none"> (i) Rely on increasing transactional volume, and increasing the diversity of participants. (ii) Present a different set of value propositions to buyers and sellers. (iii) Diversify and broaden the business functionalities supported, to counter competition from private markets, and other independents.
Strategies for the Buyer	<ul style="list-style-type: none"> (i) Improve inventory management through collaborative planning, etc. (ii) Consolidate sourcing channels, and standardise purchasing processes. (iii) Gain access to important market information, such as the availability of products 	<ul style="list-style-type: none"> (i) Conduct spot purchases to overcome unforeseen demand spikes. (ii) Gain access to a greater pool of sellers, vendors.
Strategies for the Seller	<ul style="list-style-type: none"> (i) Gain access to greater business certainty and security by securing major contracts. (ii) Move away from price-based strategies, and concentrate on product differentiation to prevent commoditisation of products. (iii) Improve relationships with customers, such as through collaborative planning and design. 	<ul style="list-style-type: none"> (i) Get rid of excess inventory, (ii) Use them as a low cost channel for accessing non-existing trading partners, especially if the buyers are fragmented, and difficult to access.

willing to incur the additional cost of participating in B2B Electronic Markets, simply to enjoy a marginal cost reduction from savings in transaction cost. For major buyers and sellers, the volume of their transactions may justify this decision easily, but for those that have less volume, or already have well-established relationships with existing trading partners, the decision for joining B2B Electronic Markets requires an evaluation of whether it aligns with the organisation's core business, and how it will improve its core business.

From the perspective of an individual buyer or seller, the decision to join a B2B Electronic Market is frequently influenced by decisions by its major trading partner to join, or a group sign-on by its trading community. While the network externality effect may describe the typical network benefits for the individual buyer or seller, these organisations must be prepared to perform substantial modification or transformation of their existing internal processes. Integration of internal and external business processes represents a major hurdle for some organisations, but also an incentive for those that intend to pursue process automation.

V. Conclusion

The paper contributes to practice and research by presenting rich empirical insights into the operations of B2B Electronic Markets, and providing suggestions for future research in the

topic area. It also highlights the importance of the traditional process for formulating business strategies, albeit one that is adapted for a faster-paced B2B Electronic Markets environment.

In conclusion, the study found that an important element to effective and successful strategies lies in the ability of the B2B Electronic Market system to foster collaboration, and encourage participating organisations to draw synergy from mutual strength and expertise. Pitting participating organisations against one another to achieve price-based reduction is but a short-term tactic. As interest among participating organisations to compete on price wanes, the viability of the B2B Electronic Market is threatened. For market-makers in particular, the ability to generate and distribute business value fairly provides additional motivation for stakeholders to participate.

Secondly, the adoption of B2B Electronic Markets requires business strategies that are not much different to adopting new business innovations. For participating organisations, an important element to effective and successful strategies for B2B Electronic Markets is to have adequate long-term planning, and be able to focus on measurable and achievable goals. Frequent recalibration and readjustment to business strategies are indicators of inadequate planning, or the lack of understanding of B2B Electronic Markets.

Last, but by no means least, the paper highlighted the need for managing business process transformation that

accompanies B2B Electronic Markets. In-depth understanding of existing business processes, and the capabilities of B2B Electronic Markets, prevent hasty strategies that require frequent recalibration. In addition, these three major findings represent areas that require further research in order to determine qualitative-type effects of B2B Electronic Markets.

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How Smart Card Technology Could Be Used for Dynamic Pricing in Transportation Network?

Ting Li, Eric van Heck, Peter Vervest

Department of Decision and Information Sciences

Rotterdam School of Management / Erasmus University, The Netherlands

{tli, evanheck, pvervest}@rsm.nl

Abstract: The past decade has witnessed an increased application for dynamic pricing in transportation industry, where firms use various forms of dynamic pricing to respond to market fluctuations and uncertainty in demand. In light of the success in the airline dynamic pricing practice and given the advancement of the ICT technology, the question is raised as follows: can technology adoptions, such as smart card, help the transportation companies, especially public transport operators, to approach the dynamic pricing in an innovative way? By using the case of the smart card adoption in the Dutch transportation industry, this article articulates the opportunities the smart card brings to the dynamic pricing design and use. It is demonstrated that the smart card data gives a dimensional view on the travellers, where both the market segmentation and the travel behaviour could be better studied. It is also argued that the rich segmentation information on the travellers and the increased understanding of the travel behaviour could lead to the level of refinement of the dynamic pricing strategies for the transportation companies. Furthermore, a number of dynamic pricing strategies are proposed that correspond to the discussed smart card dimensions.

Keywords: Emerging technology, case study, smart card, dynamic pricing.

I. Introduction

The past decade has witnessed an increased application for dynamic pricing in transportation industry, where firms use various forms of dynamic pricing to respond to market fluctuations and uncertainty in demand. One particular example is the dynamic pricing strategy used in the budget airlines (some examples are easyJet and Ryanair in Europe and jetBlue in the U.S.). These airlines typically offer only one type of ticket on each flight, a non-refundable, one-way fare without advance-purchase restrictions. However, they offer these tickets at different prices for different flights, and moreover, during the booking period for each flight, vary prices dynamically based on capacity and demand for that specific departure [16].

The other transportation companies, especially public transport operators (PTOs), however, are in the dilemma and having difficulties in fully taking advantage of the dynamic pricing. On one hand, there is a definite need. Transportation

planners and public transport operators alike have become increasingly aware of the need to diffuse the concentration of the peak period travel. Dynamic pricing is argued as one of the most preferred revenue management method [16] to both reduce the peak travel requirement and increase the capacity utilization. And on the other hand, there is a practical limitation. Without deploying booking and reservation system as the airlines do, PTOs are not able to manage the variable demand of the heterogeneous travelers and spread them over the course of the day or the week.

At the same time, the rapid development of information communication technologies (ICT) and the expansion of the Internet have deeply affected the way in which various transport operators deploy and exploit their products and services in the transportation marketplace [6]. The advent of the emerging transportation ICT technologies, such as automatic vehicle location and tracking (AVLT), automatic data collection (ADC) and automatic fare collection (AFC), from the travelers' perspective, has provided enormous travelers' transit information (i.e., real-time traffic information) and enhance the quality of their travel experience. From the transport operators' perspective, they are striving to adapt their business processes to take advantage of the possibilities that these emerging technologies offer.

In light of the success in the airline dynamic pricing practice and given the advancement of the ICT technology, can PTOs be inspired to get out of the dilemma? Specifically, will the transportation ICT technology help the PTOs to approach the dynamic pricing in an innovative way? Unfortunately we are still a long way from fully understanding the possibilities as we have only begun to recognize the potential of these transportation ICT technologies. Before we can design the strategy (i.e., dynamic pricing) to take maximum advantage of the new and emerging technologies, we need to have a clear picture of what such emerging technology could offer. The answers to the above questions are sought in a case study approach. By using the case of the smart card adoption in the Dutch transportation industry, this article offers a contribution by outlining several dimensions of the smart card attributes along which a number of pricing strategies are proposed.

The reminder of the article is organized as follows. The article starts with a review on the existing literature on ICT adoption and dynamic pricing. These two theories are developed into a conceptual framework. Next, an explanation of the empirical setting in the smart card adoption in the Dutch transportation industry is given,

together with research method and data. This section is then followed by presenting the empirical analysis, which emphasises on the smart card attribute dimensions and the innovative pricing strategies that linked to each dimension. The article ends with conclusions and suggestions for further research.

II. Literature Review and Conceptual Framework

This section discusses dynamic pricing and ICT operational adoption, which appear to be essential for this article. These two theories are then developed into a conceptual framework.

II.1 Dynamic Pricing in the Transportation Industry

Dynamic pricing can be formally defined as the selling of goods in markets where prices move quickly in response to supply and demand fluctuations. Charging different prices for the same product is price discrimination [5]. One type of price discrimination, second price discrimination, is based on identifying the willingness to pay of different groups of customers through their purchasing behaviour. Economic theory argues that dynamically changing prices is inherently good for the profitability of the firm, because it allows the firm to capture a larger share of the consumer surplus. Consumer surplus is viewed as the difference in the price that the customers are willing to pay and the actual price that they end up paying. Price discrimination moves some of the customer surplus to the suppliers.

It has long been the tradition of transportation companies, especially airlines, to use the flexible pricing strategies to manage their perishable inventory efficiently. Argued by Boyer [5], transportation companies are in an especially good position to engage in price discrimination. This is mainly because that it is generally possible for the transportation companies to satisfy the characteristics that are common to the applications of the dynamic pricing [12]. These characteristics include the following: 1) managing relatively fixed and inflexible capacity; 2) the inventories are perishable; 3) existence of variable and uncertain demand; 4) the customers are heterogeneous, however, could be segmented; 5) the companies have appropriate cost and pricing structure; 6) the data and information system infrastructures are available.

II.2 ICT Adoption in the Organization

The impact of general ICT adoption in the organization has been extensively studied in the past decades. Three major research streams in regard to the impact on the organizational performance could be identified. 1) Cost reduction. Many researchers have argued that ICT is particularly useful in information-intensive activities, since the use of ICT might lead to the reduction of coordination costs and therefore, decrease transaction costs [10]. 2) Revenue generation. Some authors have investigated how the use of ICT might affect revenue generation in

information-intensive activities. For example, Bakos [3] supports the claim that using ICT supports new pricing strategies. 3) Increase flexibility. Some authors have stressed the possibilities of ICT to increased interorganizational flexibility [13,21].

The ICT technologies that are adopted in the transportation industry have been systematically analysed by [9]. Furthermore, their paper also offers a more general view on the impact of the ICT adoption on both personal travel and commercial vehicle operations. In the smart card literature, although there are comprehensive reviews of smart card technology and its commercialisation [15], many of the papers have focused on either technological aspect or the payment aspect [18] of this ICT adoption. Only until recently, the smart card adoption affects on the data collection process have been studied through Bagchi and White [2] empirically examination in the UK bus operation.

Being one type of ICT adoption, smart card based automatic fare collection systems are being introduced all around the world in the transportation companies. Being the first setup, Hong Kong's "Octopus" card has more than 5 million active users since the adoption in 1996. Singapore's "EZ-Link" card also reaches a 5 million user base since 1999. Transport for London (TfL) adopts "Oyster" card on its London transport system that covers tube, bus, trams and national rail services, and have attracted 7 million users. The widespread adoptions have undoubtedly exemplified the great interests of PTOs on the smart card technology. Now the question is: are the adoption of the smart card technology in the transportation companies could leverage the opportunity of the dynamic pricing?

II.3 Conceptual Framework

The following conceptual framework depicts the potential influence that the adoption of smart card in the transportation companies may influence the design and use of the dynamic pricing. Based on the literature review we formulate the following proposition.

Determining the "right" price to charge a customer for a product is a complex task, requiring that a company know not only its own operating costs and availability of supply, but also how much the current customer values the product and what future demand will be [7]. Therefore, to charge a customer the right price, a company must have a wealth of information about its customer base and be able to set and adjust its prices at minimal cost.

The term dynamic pricing is used in this article to broadly encompass tariff structures that adopt differentiated pricing [5], in which different buyers may receive different prices, as opposed to the auction pricing mechanism that has prices and conditions based on bids by market participants [11]. The practical motivation for developing dynamic pricing options can probably be traced to the need to reduce the peak load requirement, the variable and uncertain demand, as well as the profitability of the firm.

Tremendous data could be obtained through the usage of the smart card by the transportation companies. These data

can be used to derive the detailed traveler information over the cost that users are willing to undertake. Unlike the traditional time-consuming survey method where the changes are observed slowly because of the information delay, the smart card becomes a powerful tool for almost instantaneous consumer feedback. The key advantage is that it provides a detailed understanding of willingness-to-pay and traveler characteristic information. This should provide more accurate price-demand projections than are attainable via the traditional survey methods. Transportation companies could then design their pricing strategies to separate the higher and lower price segments: to separate the travelers that are sensitive to the price change (recreational traveler) and people that are insensitive (home-work traveler).

The adoption of the smart card in the transportation companies provides 1) increased availability of traveler data, 2) opportunity to change the prices more easily, and 3) potentials to combine with the decision support tools for analyzing the demand data. These improvements allow the PTOs to design and use the dynamic pricing strategies that they are not capable earlier, when the companies had limited ability to track information about their travelers and faced high costs in changing prices [7]. Thus, we have:

Proposition 1: Smart card adoption of the transportation companies leads to the design and use of dynamic pricing.

In light of the smart card adoption in the Netherlands, the PTOs have many questions concerning the impacts of the adoption, including technological, social, environmental, commercial and operational aspects. Because of the limit in space, this article will mainly focus the relationship to the dynamic pricing, which distinguishes itself and also makes an important contribution to the similar research of this kind [1,4,17].

III. Research Context and Research Method

This section elaborates the research context and the research method. The above-mentioned conceptual framework will be studied based on the case of the smart card adoption of the Dutch transportation industry,

III.1 The Context

The way in which people use public transport in the Netherlands is changing – as it is in cities and countries across the globe. Trans Link Systems (TLS) plans to deliver a seamless ticketing and fare collection system for the complete public transport system throughout the Netherlands. The system will initially be rolled out in Rotterdam in September 2005 and extended to cover the whole country by the end of 2007. Using smart card and readers' technology, this all-encompassing contactless ticketing infrastructure will cover trains, metro, trams and buses – providing travelers with increased convenience and added satisfaction. At full implementation the system will have to contend with

an estimated 1.5 billion transactions each year.

III.2 Research Method and Data

Case study research is chosen to test the proposition as it investigates a contemporary phenomenon within its real-life context [23]. The rationale for selecting the single case - the smart card adoption in the Dutch transportation industry - for is being representative [23]. And at the same time, it satisfies two criteria for the case selection: 1) the smart card technology is being implemented, and 2) different pricing strategies are being considered while the introduction is taking place.

Data was collected through personal interviews, documents, websites and previous researches. Taking the full strength of the case study method, this data collection approach also tries to enhance the validity of the research. In total, 12 interviews were carried out with people from marketing, commercial, research and logistics departments at different management levels in transportation companies as well as public institutions.

IV. Analysis of the Empirical Data

In this section, an empirical analysis of the gathered information will be performed. After presenting the lack of information problem that occurs in the current situation, it demonstrates the dimensional classification of the smart card data attributes. As a result, a number of dynamic pricing strategies for the railway travel are proposed that correspond to the discussed dimensions.

IV.1 Lack of information in the current situation

There are mainly two ways for the PTOs to gather the travelers' information in the current situation. First, the PTOs would have some records of their frequent travelers who left their details after their purchasing. Second, different surveys are conducted every year or every few years to cover different aspects of the travelers' information. For example, there are surveys that look at the characteristics of the travelers, the frequency of the travel and the preferred time of the travel. However, the questions concerning what type of product their travelers use and when exactly they use it are still largely remain outdated, inaccurate and even unknown.

IV.2 Smart Card Data Dimensions

Each time the smart card is used, either to make a trip or to purchase/renew a travel product that loaded to the card, details of the trip and/or product made with the card will be captured and linked to that smart card or the individual if the smart card is registered under that individual. The smart card, hence, gives the PTOs the opportunity to capture the behavior of the travelers more easily.

The information extracted from the smart card data consists of the origin and destination of the travel, the travel time at the origin and the destination, and the transport services that the travelers use. The transport services include

the mode of the transport and the vehicle type of that particular transport mode. For example, for the train travel, the vehicle type may vary from international train, intercity train, fast train, and slow train. If the smart card is not “transferable”, which means only the card holder is allowed to use the card, it may also contain the profile information of the card holder, for example, age, gender, name, address and maybe profession. Privacy concern would be relevant in this context, however, is out of the scope of this article.

The smart card data attributes (depends on the specific implementation) could be classified into five dimensions (see **Table 1**). The categorization is largely based on the smart card data attributes that are presented by Bagchi and White [1]. The categorization gives an indication on how the travelers could be segmented. For example, in the spatial dimension, travelers could be segmented based on different origin-destination route; peak and off-peak period travel segments the travelers in the temporal dimension. The five dimensions are:

- *Temporal dimension*: time and date of departure and destination;
- *Spatial dimension*: departure and destination of the travel;
- *Service dimension*: travel mode and vehicle type;
- *Personal dimension*: traveler’s name, age, gender, address and profession;
- *Buying dimension*: travel product purchase time/date, location and price;

Table 1: Smart card data attributes and its dimensions (adapted from Bagchi and White, 2004)

Smart Card Attribute	Smart card	Temporal dimension	Spatial dimension	Service dimension	Personal dimension	Buying dimension
Card number	x				x	
Cardholder name and address	x				x	
Cardholder age	x				x	
Cardholder gender	x				x	
Travel origin	x		x			
Travel destination	x		x			
Time / day of departure (origin)	x	x				
Time / day of arrival (destination)	x	x				
Transport mode and vehicle type	x			x		
Product purchase time and date	x					x
Product Purchase location	x					x
Type and price of product	x					x
Travel purpose						

Travel purpose: The travel purposes that are now collected with the travel survey cannot be captured with the smart card.

IV. 3 Dynamic Pricing Strategies

As one of the most important price-based revenue management techniques, dynamic pricing has a direct, and sometimes dramatic, impact on operations and vice versa [8]. Dynamic pricing is one possible method to manage demand and reduce the peak load requirement. In this section, a number of dynamic pricing strategies for the railway travel are proposed that correspond to the previously discussed smart card data dimensions. For each strategies proposed, an explanation on how it works is given together with specific examples on the pricing scheme.

Table 2: Smart card data attribute vs. tariff structure

Smart card data dimension	Dynamic pricing strategy
Temporal dimension	Time-based pricing; (time-of-day; day-of-week)
Spatial dimension	Directional pricing; Regional pricing;
Service dimension	Usage-based pricing; Demand-based pricing;
Personal dimension	Age-based (e.g., 65+); Profession-based (e.g., student);
Buying dimension	Periodic fare product promotion

Temporal dimension: *Time-based pricing* is by far the most frequently used pricing strategy among all the proposed ones by the transportation companies.

Time-based pricing. In the Netherlands, the morning peak hour is defined as between 7:00-9:00am each weekday. The periods after 9:00am and the weekends are defined as off-peak. In practice, a reduction card is available for the travellers who travel during the off-peak, which gives them a 40% reduction on the travel. This reduction policy is an example of time-based pricing. It is argued that giving discounts to travelers during the uncongested off-peak should attract much less opposition than an extra (punitive) fare on peak-hour travellers [20]. Other example of this time-based pricing strategies are: for the time-of-day strategy, introducing the pre-morning peak (cheaper fares before 7:00am); for the day-of-week strategy, introducing lower weekend fare; There are many time-of-day priced services already in practice, including telephones (cheaper evening and weekend rates), movie theatres (the matinee show) and restaurants (the “early bird” special).

Spatial dimension: Dynamic pricing strategies that are designed by using the spatial dimensional data are: directional pricing and regional pricing.

Directional pricing. Apart from the time-dependence of the travel demand, the directional imbalance, which means unequal demand in both directions, also heavily impacts the load factors of the PTOs. In a normal weekday, the railway operation data shows that during the peak hours the trains are crowded while moving to the direction of the big cities, whereas they may be almost empty on the other direction. In fact, majority of the travelers who travel in the morning peak are the ones who either work or study in the destination city but live in another city. As expected, the dataset for the afternoon peak between 16:00 to 18:00 demonstrates an opposite directional pattern. PTOs can apply several

strategies to accommodate this imbalance [14], among one of them, direction-dependent differentiated pricing could be expected to have a positive effect on improving the load factors as well as the profit.

Regional pricing. Similar to the zone-based pricing in some cities for the bus and the metro transport, regional pricing in the rail transport could be thought of as applying different regional tariff to each region. For example, a differentiated price could be charged for the traveling to and from the most important cities in the *Randstad*. (*Randstad* is the metropolitan area in the western part of the Netherlands, including major cities, such as, *Amsterdam*, *Rotterdam*, *The Hague* and *Utrecht*. It has high work availability, many multinational corporations and universities that attract many people to work and study.) Hence, the travel demand of this region is significantly higher than the average demand of the rest of the country. van Vuuren [19] has proved that peak hour seat kilometres on dense tracks are underpriced, both from the profit-maximizing perspective and from the welfare-maximizing perspective. In fact, it has been considered of adding an additional unit of tariff to the current tariff for the people traveling to and/or from *Randstad*. Another option is to reduce the price of travelling in the less populated area, such as the east of the country. To make it even more sophisticated, different prices could be charged for different origin-destination pairs. This is because the trains on some tracks are more crowded than the others.

Service dimension: two innovative pricing strategies, namely, usage-based pricing and demand-based pricing are introduced in this dimension.

Usage-based pricing. For the travel card holders, who have month card, trajectory card, etc., there is no fare charged for the additional travel. Thus extra travels, such as returning home to lunch from work, weekend family visit etc., are “free”. An earlier empirical analysis [22] has shown that the travel card has lower price elasticity than the single ticket. This means the travelers that have travel card are less price-sensitive than those of the single ticket. With the introduction of the stored-value-ticket, these travelers who travel more than the average will choose to stay with the travel card. While on the other hand, people who use the travel card less than the average will switch back to the single ticket. In the usage-based pricing scheme, travelers are billed on the actual travel kilometers during any given month. There are a number of options for implementing this usage-based pricing. 1) Pay-as-you-go. Fixed costs are charged for every kilometer a person travels. 2) Contract for fixed amount. A contract is signed between the traveler and the PTOs for a fixed amount of kilometers given a certain price. 3) Product bundle. It is a pricing scheme that consists of a premium and a charge for the additional travel being made.

Demand-based pricing. Assume the travelers’ boarding information is captured at virtually real time, the PTOs then know the total demand and consequently the utilization of the transport vehicles. The demand-based pricing proposes to let the tariff vary based on the travel demand. In that case,

the PTOs could decide on for example, lowering the prices for the traveler when the total travel demand exceeds certain level or the utilization is higher than a given rate.

Personal dimension: Different travel cards could be designed for people in the different profile group. For example, student travel card or travel card for senior people above 65 years. Some of these are already implemented in practice.

Buying dimension: Periodic promotions to attract new travelers are considered as the pricing strategy that fits into this dimension.

IV. 4 Refined Conceptual Framework

Based on the analysis of the dimensionality of the smart card attributes and the proposed dynamic pricing strategies that map into the dimensions, a refined conceptual framework (see Figure 1) is developed through a set of refined hypotheses.

Hypothesis 1: Smart card adoption in the transportation companies provides rich information on travelers’ segmentation.

Customer segmentation is the practice of dividing a customer base into groups of individuals that are similar in specific ways relevant to marketing. Using segmentation allows companies to target customer groups effectively.

The smart card data provides rich information on travelers on the discussed dimensions. These data and/or together with other data sources could then be used to analyze the segmentation of the travelers. There are many ways to segment the market as can be seen from the number of data attributes along different dimensions. Travel purpose is by far the most frequently used segmentation in the transportation industry. Although the data on the travel purpose will still not be possible to obtain by using the smart card, it is generally available via survey method. For example, distinctions could be made between commuters (home-to-work or home-to-study traveler), business (first class traveler), and recreation (holiday or shopping).

Hypothesis 2: Smart card adoption in the transportation companies leads to better understanding of the travel behavior.

Travel behavior research is the study of what people do over space, and how people use transport. The questions studied in travel behaviour are broad, such as, how many trips do people make? Where to they travel to and from? What mode do they use? When is the trip being made? etc. These information are traditionally obtained by using travel surveys. Conducting survey, especially large scale travel behavior survey, requires big efforts and spans long period. Smart card data enhance the ability of the PTOs to know where the people travel to and from, at what time, and at what price. It is important to note that the revealed segmentation information of the travelers is different from understanding the travel behavior. The latter concerns some issues in a broader scope. Besides the ones mentioned, other travel behaviour related questions are: what is the pattern of

trips? Would the price increase of the public transport affect the travelers decision making on mode choices? Is the crowdedness an important factor when people making mode choice? Answers to these questions could not be given unless more insights into the behavioural aspects of the travel are gained.

Hypothesis 3: Rich information on the travelers' segmentation leads to the level of refinement of dynamic pricing strategies.

Various empirical analyses have shown that the demand for the train transport during the peak hours is inelastic, while the demand during the off-peak is elastic [19]. According to van Vuuren [19], the motivation plays an important role for this. As the travelers usually do not have many alternatives and therefore cannot easily switch to other modes or another departure time or another track, resulting in relatively low price elasticity for the demand during the peak hours.

Price elasticity is defined as the percentage change in consumption of the good (change in demand) caused by a one-percent change in its monetary price or other characteristics, such as service quality. The gathered data from the smart card and other sources could be used to derive the elasticity information for each traveler segment. As a result of it, transportation companies could tailor their dynamic pricing strategies to different market segments in a more refined level and allocate their marketing resource more effectively.

Hypothesis 4: Better understand the travel behavior leads to the level of refinement of dynamic pricing strategies.

An example of using proposed time-based pricing strategy is to introduce an afternoon-peak (16:00-18:00) price. Instead of paying the off-peak reduction price, travellers that travel during the afternoon-peak would be charged to a higher price. The introduction of this policy is in an effort to even-out the peak travel concentration. Then the question is: would this policy shift the demand of the travelers to a less-crowded period of the day? Or will the travellers change to a different mode of travel? Answers to these travel behaviour related questions would be essential to assess of the pricing policies. And more importantly, it will lead to a more refined level of pricing strategy design.

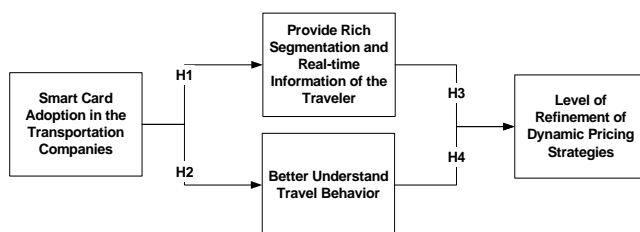


Figure 1: Refined Conceptual Framework

V. Conclusions

Based on the case study result from the Dutch transportation

industry, this article argued that the adoption of the smart card by the transportation companies on one hand provides rich segmentation and real-time information of the travelers. And on the other hand, it leads to the ability to better understand the travel behavior. As a result of it, an improvement on the level of refinement for the design and use of the dynamic pricing strategies could be achieved.

There are several suggestions for further research on the relationship between smart card adoption and the design of the dynamic pricing.

First, a number of pricing strategies have been suggested in this article. An evaluation of the potential effectiveness of the strategies needs to be tested.

One of the hypotheses suggests that travel behaviour leads to better pricing design. In order to better design the dynamic pricing strategies, PTOs should first understand their travelers in regard to their travel decisions. Despite the potential of differentiated pricing to ease the peak period public transport demand problems, there is little quantitative evidence of its ability to influence the behavior of the travelers. Therefore, future research could emphasis on answering the questions, such as, how do travelers respond to time-dependent pricing strategy during the day? Are they shifting to a cheaper period or are they paying the higher price?

Third, though the adoption of the smart card in the transportation companies offers tremendous opportunities to design sophisticated dynamic pricing strategies (i.e., individual-level price discrimination), in practice, the pricing structure has to be simple and easy to communicate to the travelers.

Fourth, it is clear that the above proposal on dynamic pricing are based on a rather idealised travel markets and only the transport operators' profit-maximising objective is considered. Travelers may express an objection for crowding, unfairness and fare complexity, which consequently might change their willingness-to-pay. To bring the models closer to reality, the future research could focus on understanding the travelers' behaviour change under the influence of the dynamic pricing, and the cost of complexity.

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Introduction of 3rd Generation Wireless Services in a Multi-Enterprise VPN Environment: Case of the Port of Rotterdam

L.F.J.M. Pau, H. Chen, P. van de Coterlet, R.A. Zuidwijk
Rotterdam School of management
P.O. Box 1738, 3000 DR Rotterdam, the Netherlands
Phone: +31 10 408 2282 Fax: +31 10 408 9010
Email: lpau@rsm.nl

Abstract: The needs as well as the bottlenecks are analyzed in the deployment and use of wireless services in a networked environment of companies sharing some common supply chain processes. The specific case is the multi-enterprise networks around the Port of Rotterdam, researched as part a large project on value-added wireless services in this environment, sponsored by KPN Mobile. New services, operational requirements, decision processes as well as tariff and organizational problems are reported.

I. Introduction

This paper summarizes the main results of a large sponsored project entrusted to Rotterdam School of Management (RSM) by KPN Mobile, in collaboration with the Port of Rotterdam authorities. Its focus was on identifying drivers and bottlenecks in the usage and creation of wireless services in the Port of Rotterdam.

It also aimed at creating an understanding for the decisions and demand processes amongst port users and different groups. For the Port of Rotterdam and its partners: the goal was to have a third neutral party elicit the use of GPRS and 3G wireless services, and propose business processes making best use of basic and value-added/customized 3G wireless services; this analysis applies to services as they exist or could be developed by the Port or its associates. RSM, in collaboration with the Erasmus Center for Maritime Economics, was in such a position to be able to extend the qualitative comparison to the identification and survey of the wireless activities at about 16 other ports worldwide.

The project was organized into three basic focused tasks addressing more specifically:

- *Logistics processes and competitive impact*
- *Basic 3G voice and data services*
- *New 3G voice and data services*

The work method used was the following. A sequence of thematic interaction sessions took place on each of the three focus tasks, aimed at eliciting key issues, opportunities and difficulties from different angles. The field work, involving each time 2-3 different RSM researchers, took place at over 80 companies or public institutions with interviews based on

thematic questionnaires and evaluation criteria. The interviewed parties were all at management level, which is rather exceptional. Contacts were also made with an additional set of 70 companies via questionnaires, and contacts or meetings were held with 25 companies outside the Netherlands. As to the research methodology, a systematic identification of bottlenecks and opportunities at the multi-enterprise business process level was carried out in all the three basic tasks above.

The verification and discrepancies were revealed by the interviews and common questionnaires/evaluation criteria. For lack of space reasons, this article only reports on the overall conclusions (Section 2), some of the findings and cases from the task on logistics (Section 3), before dealing specifically with New wireless services for port operations (Section 4). It continues in Section 5 with the related business models and organizational issues (Section 6). Readers not familiar with this sector are referred to [1], [2] for terminology.

This short presentation is not research focused but brings value to research on the difficulties in introducing 3G services into multi-enterprise environments. For obvious reasons there is not much academic literature on this subject, and even less on wireless operations in harbors.

II. Context and Overall Results

II.1 General

The Port of Rotterdam is economically an important worldwide logistics hub present in the Netherlands and involving many small and large companies and organizations to whom wireless operators would like to offer capabilities and services. The Port of Rotterdam holds one of the top ranks worldwide for a large number of major logistics and supply chain processes (and tops total port throughput in tonnage worldwide), the sheer diversity of which poses some significant challenges for wireless services (generic as well as value-added services). Furthermore, the largely decentralized nature of the actual operations and information flows, besides a consensus based nature of local decision making, and very tight operating budgets everywhere, make it difficult organizationally to map the demand for advanced wireless services with sufficient business revenue base. KPN Mobile asked to put the emphasis on 3G wireless services and their demand, which later expanded in the project to GPRS based services,

inevitably revealed a significant lack of flexibility and even resistance amongst most private actors in the Port (including shipping lines) in terms of technology migration. Furthermore, most uses of wireless communication are still tied to mobile field workers who drive a bottom up adoption process, meaning that in the best case GSM, and in some rare cases GPRS, are still “good enough” and that no specific investment budgets exist for service creation or wireless information gateways.

II. 2 Logistics and Competitive Position

For the actors inside the actual physical supply chains, as investigated as part of the focus task on “Logistics and competitive positioning”, the general finding is that there are no indications that they will adopt 3G on a large scale in the short term. Nevertheless, the identified logistics development trends driving the adoption of 3G services amongst these actors are the administrative complexity and exception handling, the migration from voice to data, and external drivers like US safety/security regulations. The bottlenecks were insufficient wireless dependability, back office and broadband fixed Internet as alternatives, and the politics and power of supply chain relationships.

II. 3 Basic Services

For all users (service focused or physical flow focused) of generic wireless services, covered in the related focus task “Basic services”, whether small and middle sized enterprises, large organizations, or those with very unique service contexts, the dominant issue is one of perceived (or observed) GPRS and 3G tariffs, as they risk to impact field operations and permanent operations which should not in their minds be charged per minute or MB. Even if public sector users may have less concern for tariffs and may be earlier adopters/pilot sites, the likelihood that their adoption will spill over to 3G services is minimal. Another important factor is that, in significant cases, the decisions to adopt GPRS or 3G basic services, are not made in the Port area at all but elsewhere in the Netherlands or abroad which render local marketing of generic services ineffective. Other limiting factors are the difficulties or costs to find specialized terminals working in a dependable way in a Port context, as well as the lack of truly experienced custom mobile application integrators with logistics understanding able to develop reliable solutions.

II. 4 New Wireless Services

The field of new wireless value-added services benefiting the Port of Rotterdam business environment is rich in concepts and interested parties, but poor on actions and players leading integrative projects for wireless information distribution, or for productivity gains. When some analysis or prototyping has been done, GPRS value added services are still preferred over 3G for the foreseeable mid-term future, not the least because too few business processes in the Port (except safety related) demand high data rates or close-to real time performance. Also, other major bottleneck

factors are the lack of a single trusted neutral party for information services, and the absence of revenue based thinking as opposed to cost cutting and/or passing on costs (such as wireless services) to customers.

The comparison with other ports shows that a centralized accountable actor or a dominant user, are always factors for faster adoption of wireless services on sound cost/revenue basis, as opposed to “nice to have” basis.

The research has also shown that alternative technologies and services to 3G such as WLL, WIMAX and even WiFi, are a real threat when driven by sound business models (such as managed services), clear trusted ownerships, and above all low costs to users, for same or better dependability and security.

II. 5 Proposed Approach

To unlock this situation and allow for Port users to gain the benefits of 3G, the most pragmatic approach seems to involve one or two business and revenue driven focused private sector deployment initiatives of innovative services with a clear leader driven by short terms commercial benefits to just a few partners. This can very well happen if a major actor decides top-down for the productivity gains of linking better his operations in the Port with his traditional and closest suppliers or customers. Reinforcing the feasibility of this approach would be the availability of customizable tools for cost and revenue modeling of New 3G services, supplied either by the mobile operator(s) or, better, by a neutral party. Also, well publicized, and “simple to understand” tariff packages for closed subscriber groups using generic 3G services, seem necessary with minimal bureaucracy/sales efforts, e.g. using subscriber self-care options. Beyond, a policy discussion should enable the framework for one party in the Port to emerge as the sole fully trusted for information collection and selective sharing, without commercial conflicts as derived from e.g. privatization.

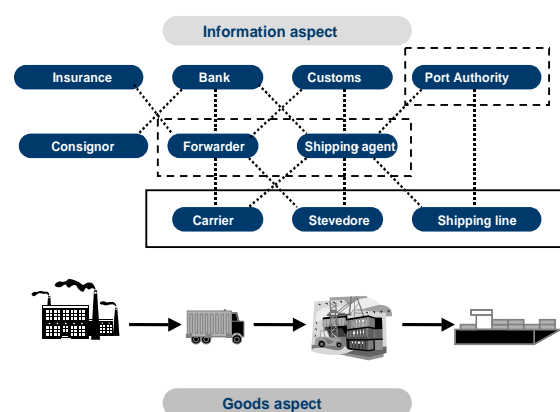


Figure 1: Information and goods views of Port interactions

III. Wireless Usage in Port Logistics and Supply Chains

III.1 Introduction

Supply chains extend over the globe from sourcing raw materials and supply of intermediate parts and products to delivery of goods to end customers, and collection of product returns for environmentally conscious recovery and disposal. As a node in these global supply chains, the port of Rotterdam accommodates transshipment between deep-sea vessels and transport modes that service the European continent and hosts production and other value-adding services. (Figure 1)

Transport modes or means of transport are feeder, short sea shipping, barge, train, truck and pipe lines, supplemented by air cargo. The cargo varies from liquid and dry bulk to (containerized) discrete products. Next to being an enabler, the port of Rotterdam also needs to guarantee health, safety and security of cargo, traffic, industrial complexes and the city. Recent developments here are tightened food safety regulations and anti-terrorism regulations and measures.

III.2 Administrative Complexity and Exception Handling

Although the physical process of transshipment seems simple, the linkages between the organizations and resources involved constitute a complex network (figure 1) [3], [4]. For example, in the port area, hundreds of trucks each send out numerous messages related to (pre-notifications of) arrivals and departures at terminals, pick-up and delivery of cargo, etc. A distinction needs to be made between messages that confirm planned execution and messages that contain alerts indicating that planning could not be met. Another case is given:

FIELD EXAMPLE 1: FOOD AND CONSUMER PRODUCT SAFETY AUTHORITY

Current Situation

After an on-site cargo quality inspection visit by the Food & Consumer Product Safety Authority, the cargo is either cleared for further transportation or a sample is taken to be inspected in the laboratory at the back office. This notification is presently done by voice through a mobile phone. After establishing contact, the planner may provide the inspector with planning adjustments. Upon returning to the back office, the inspector is responsible for uploading (so called signing-off) the inspection data from his laptop on the computer system for further processing. Planners are, next to ensuring and adjusting smooth inspections planning, responsible for providing the inspector with necessary information and giving input for the planning of laboratory activities. These activities cannot be handled efficiently under the current circumstances.

Wireless enabled vision

Forthcoming European legislation, called the General Food Law, requires import and in-transit cargo to be inspected in the country of entrance, instead of in the country of clearance. Since the Port of Rotterdam is a major port of entry for large cargo volumes with destinations all over Europe, this would result in an increase in the

number and diversity of inspections, and possibly more ad hoc inspections to be conducted by the cargo quality inspectors in the Netherlands. The present staff of 10 inspectors may increase fivefold. Such an increase would make the planning of inspections and scheduling of inspectors extremely difficult. Perceived opportunity here are 3G services, especially when coverage in the Netherlands is assured.

III.3 Integration of Mobile Resource Support Systems and Mobile Communication Systems

Mobile resources such as pilots and truck drivers use electronic devices that support decision making at remote locations. When mobile communication is required, one can expect additional benefits when decision support and communication possibilities are integrated. Two field examples are summarized:

FIELD EXAMPLE 2: PILOTAGE PORTABLE PILOT ASSISTANCE (implemented by Loodswesen in Rotterdam since May 2004 using 3G and GPRS)

Prior Situation

Pilots control the boarded vessel and navigate it in a safe and efficient manner to the destination terminal in the port. Efficient and safe management of vessel traffic is highly dependent on the availability, reliability, timeliness and accuracy of data. These data are generally of three types: (1) environmental information: metrological and hydrological data (real time and forecasts), tides reporting scheme, (2) vessel information: both static and dynamic data, e.g. vessel characteristics and restrictions, to be provided to tugboat companies for towage requirements, and (3) (surrounding) traffic information: traffic density expectations, path predictions, traffic image, port and waterway infrastructure (opening times of locks, berth allocation, etc). Traditionally, the pilot relied on information by sight, voice radio communications (VHF) and radar. The information provided to the navigator originates from the vessel itself and from external sources, which is not really real-time.

Wireless enabled vision

To be able to achieve the needed improvements, the pilots are equipped with an advanced mobile device: the PPU (Portable Pilot Unit) made of a laptop with 3G data cards. The amount of data transmitted under current circumstances is 70 Mb during a time period of several hours. The data consists of hydrological data, meteorological data and a track table or traffic image of the VTS. The pilots would like to receive additional data on reporting, passage plans, metrological data from other 'sensors', information about hazardous materials, predictions of traffic flows and traffic intensity, and meteorological and hydrological data currently 'owned' by the Port Authority. The operational trials confirmed that UMTS can provide the needed bandwidth to support these users.

3G / RFID PROTOTYPE: TRACKING CARGO STATUS VIA RFID

For logistics service providers, applying RFID tags on goods could be useful, especially for theft-sensitive goods. Now these goods are loaded in a sealed part of the truck. With a camera in combination with RFID tags these goods could be better monitored and thus better service to the customer could be provided. Continuous matching of the RFID tag on the product with the order destination (e.g. coupled to the board computer and mobile communication) provides better security possibilities. Goods security can be made easier, also loading and unloading can go much faster in the warehouse. With RFID tags and readers, retyping of stock lists and one by one reading of barcodes is not necessary anymore. However, given the lack of global standards, the initial investments and relative high costs (e.g. compared to barcodes), as well as the needed redesign of the supply chain processes, RFID is still seen as a technology of the future by the companies interviewed., although prototypes are built .

III. 4 Bottlenecks

Legacy Systems and Projects

Quite a few organizations in the Port are actively developing applications of IT in order to improve the performance of their logistics operations. Although this attitude may facilitate adoption of 3G, recent or on-going innovations within these organizations hinders adoption of another technology such as wireless.

Back Office and Fixed Network

Mobile resources usually need to communicate with their back office on a regular basis. However, when employees regularly have a fixed data network connection at their disposal, a mobile data connection may be redundant. Perceived security problems with mobile communication contribute to the fact that the described situation is considered satisfactory. For the same reason or for operational control, communication via back office may be preferred over direct communication between mobile resources and other organizations.

Supply Chain Relationships and Assessment and Redistribution of Benefits

Information exchange in the Port with mobile resources involves several organizations in most cases. Moreover, in order to coordinate supply chains, information needs to be integrated beyond organizational borders. Sharing of operational data meets resistance when parties do not trust each other. Because 3G mobile services are part of an inter-organisational system, where data needs to be shared, this bottleneck needs to be taken into account. A clear distinction in access rights, authorisation levels and (re)distribution of benefits is needed to achieve adoption, especially in cases where one organisation needs to make the investments and the other gains the benefits.

Network Scope and Coverage

A main bottleneck is the dependability of the 3G basic service coverage. If the wireless network is not 100% reliable, the service will not be adopted. Even a low-QoS

event can be disastrous for the operations performed and the revenues of Port parties. Therefore, UMTS will be an option when other parties start using it as well in an integrated manner, possibly on a port community level, which is connected to service creation and private VPN's, port authorities and partners.

IV. New Value-Added Wireless Services For Port Operations

Although not all interviewed parties had any concrete ideas or plans, some did, and to better understand the business drivers and bottlenecks, they are mentioned here in Table 1.

NEW SERVICE CATEGORIES	Description
Generated by interviewed parties	<ul style="list-style-type: none"> •Image transmission of damaged goods with images taken by camera associated to a mobile phone, or a mobile terminal with built-in camera; so far the image quality, the cost of transmission and sometimes low perceived security, are inhibitors •“Virtual fencing” security services by connecting in a wireless way cameras, biometric card readers, guarding towers and tours, need to know and information handling •Gate-in gate-out image collection of containers: this was mentioned but it was unclear what the gain was as containers had to be opened •Mobile arrival/departure notification: SMS broadcast of ship arrival or departure information, as a free information service to users in the Port; broadcast, or send on request, actual real time arrival/departure times and locations for ships, barges, trains •Tracking and tracing information distribution about containers and some other freight, either for one single port operator, or across parties; while the first is possible, three actors in the Port have it or plan it (one port operator, two logistics supply-chain companies) and it is deployed elsewhere, the second looked unlikely for information sharing reasons; track departing and arriving containers by physical location and administrative handling status; compartmentalized eventually by line or container fleet owner; report back by voice+data about special conditions/anomalies •Workforce assignment and localization; this involves sending dispatch and destination orders to staff in the field; this has been prototyped with GPRS and requested deployment in 2006 timeframe; the GPS localization aspect was mentioned, is already applied to vehicles, but here are questions as to need to and privacy issues relating to extending it to the handheld terminals •Mobile VPN tunnelling is deployed, but not by mobile operator, but inside applications; in one case an additional crypto facility was enabled to the tunnelled messages •Wireless distribution in the field, with text search facilities before downlink, in huge textual data bases (legal procedures, safety procedures,

	etc) •Multimedia wireless dangerous goods inspection with data retrieval •Integrated dispatch, technical action, reporting, and financial settlement in field support tasks; one such system is already deployed using GPRS and will stick with GPRS for 10 years •Maintenance logs about ship engines or elements •Passenger lists •Ship or vessel location services, for both port operations as well as for ship passengers
Generic services	•Managed VoWi voice over WLAN hot spot areas, in areas where voice traffic intensity would yield to high costs if 3G was used; interoperability with 3G/PSTN/(in future: VoIP) wide coverage basic services •IP-to-PSTN breakout service to pipe voice calls across a company or home office or home WLAN network •Picture data archive filing and management service, with batch sorting / compression /indexing / distributed access control
Content/information distribution based new services	•Distribution of long-term agreements and tariffs to shipping lines' account managers while meeting customers; this service is rivaled by Internet access and put back by the need to handle paper copies •Generic customizable wireless staff dispatching application: Staff and special equipment/ vehicle dispatching orders and acknowledgments; organized by domains and/or terminals •Fleet management application with content managed by fleet owners and operators
Business process support	•Exception alarms sent by SMS; this was mentioned, but not in a specific application context, and is/can be handled without a value-added application if data entry (voice or message) are made easy •Accident insurance claim evidence and reporting assembly and distribution, including multimedia evidence •Cleaning/refueling/resupply/personnel landing/etc. information dispatch service for a specific ship arrival across company partnerships •Emergency service coordination (fire-fighters, security, police) on Port premises, with pushed-down info about vehicle/ship/truck

Table 1: New service ideas generated

The only prior Pilot at the Port of Rotterdam was a Customs X-ray container scan with wireless transmission of scanned images. Although a feasibility prototype was built for the Port of Rotterdam Customs in 2001, with GPRS for image transmission and resulting productivity gains, this was never put in service because the transmission time of the huge image files was too long; this would not change much with 3G.

V. Business Factors and Models for Adoption of New Wireless Services in Port Operations

The main business drivers for ideas and concepts of new services were:

- information services benefiting eventually organizational capabilities and flexibility
- outright productivity gains linked to faster and acceptable mobile access to employees, thus reducing physical transport, in a way similar to mobile field support operations; to this category belong ship and goods inspection and field support tasks, which both have significant volumes of process instances (typically 8000 task instances/year and higher); GPRS or 3G effective data speeds were a gain, but far less important than the gains obtained by the sheer wireless access and its end consequence of speeding up in the field the different work procedures

Surprisingly enough, in the first category a) no business or revenue models were envisaged in a clear way to recoup the cost of development and operations of such new wireless information services; this effect is not due to the analysis method at all, but to another factor discussed below. The major concern was more one of control and influence. In terms of cost, all were looking to "Port (authority) money" to cover expenses, stating that these costs would be merged inside handling fees paid by the ships. In this first category a), an underlying issue with both positive and negative outcomes on business adoption, is the question of which is "the most trusted", or the "best trusted" party for information collection and distribution. If one such party emerges and is accepted in this role, new services of type a) may be deployed and adopted widely.

In the second category b), and if the existing services to be enhanced existed already with their organization, the major concerns were dependability and costs. Apparently, the perception is that 3G new services "may not work", especially as eventual GPRS based forerunners already have dependability problems. In other words, users want services which "work" and not "wonders".

The net effect of the effects discussed above for a) and b) type new services, is that those persons or groups spelling out in clear terms the business gains from 3G new services, are generally been seen as "dreamers", and adopters will "scale back" the ambitions to at best GPRS and sometimes even value added GSM services. An example thereof, is the ultimate preference of the owners of 3G Pilot at Loodswezen (supported by KPN Mobile) to use GPRS instead of 3G, as "GPRS is good enough" (as in other harbours with the same application).

VI. Organizational Factors and Bottlenecks around New Wireless Services

By far the overriding bottleneck was the organizational framework for wireless new services (GPRS and 3G) in the Port of Rotterdam in the private sector. The factors of this restriction are varying mixes of:

-A: the complete lack of easily customizable cost and revenue models for new 3G services

-B: absence of actual operational leadership, contrasting the multitude of wishes to “get involved”; this is of course linked to the fact that no specific budget is yet proposed or approved in any umbrella or public organization catering to the private sector companies operating in the Port. Any new GPRS/3G service will involve content/data sources, content/data owners, service developer (engineering), service developer (business), operations and management, revenue and cost aggregation, and last (but not least) wireless infrastructure owner. But who will be the project owner and project manager? All parties interviewed realize this bottleneck and point at the Port of Rotterdam Authority, but do not see any decisive leadership from it yet, as the Port Authority has many more pressing issues to handle

-C: the investment reluctance of most private sector companies to carry out service creation and trials together with other parties; the noticeable exception are some select few shipping lines or international container handling operations which have, or plan to have soon, global wireless operators contracts alike those they have for satellite communications.

-D: in the context of interoperability: the absence of any single body able to impose basis IT, or wireless application interface standards (PARLAY etc), application integration standards (XML, CORBA, OMA...), and document format standards for new services; the result is the risk for lack of interoperability and higher new service application integration costs.

-E: some degree of traditional mistrust as to disclosing some information about ships or containers to third parties; even in terms of the definition, establishment and management of closed user groups, mistrust is present. For governmental organizations, the first remark A) also applies, due to the multiplicity of stakeholders: Ministry of Transport, Ministry of Finance, Ministry of Agriculture, Ministry of the Environment, Ministry of Economics, Ministry of the Interior, EU Directorate general Enterprises, and finally the Port of Rotterdam Authority at a lower level. The deployment of new wireless services might be linked to a government transactions portal initiative, where there is an appointed leader: Ministry of Finance.

Another bottleneck for new service deployment is one due ultimately to cultural roots associated with physical transport, and not valuing information assets or the business processes around information handling. The consequence is in the Port of Rotterdam that, whereas in some other ports the new service owners and/or operators get also revenue from new services, these services are in Rotterdam considered at best as a cost item, the cost value of which must be minimal and bundled together with other services, some of which perceived to be more urgent than wireless services. As one institution said: “highest priorities are in-house systems, followed by Internet services and with later future plans for new wireless services”. Another facet of the

same culture is that “repeated simple processes are profitable, and flexible ones are expensive”.

In addition, and mentioned by some interviewed parties, the perceived total costs and tariffs for new services are dissuasive in the private sector, although the public sector operational divisions do not seem to be concerned. For almost all interviewed parties from the private sector, they considered that GSM data was far too expensive, GPRS was too expensive, and 3G also; they wished tariffs which, for same data amounts and QoS, should cost the same as on a corporate LAN (Ethernet or WiFi), with data flow reductions outweighed by mobility/ubiquity gains.

Whereas CDMA-2000 and DAB were not mentioned, WiFi, WLL and WIMAX were indeed seen by over ten interviewed parties as a way to achieve lower costs and independence from public 3G operators. Around WLL, a consortium including a power utility (which was granted a 12 years WLL license), a security company, an equipment vendor and some partners, have assembled a consortium aiming at offering managed video based security services for any party in the port. Some of the consortium members are already the largest GPRS users in the Netherlands, and have deployed segment specific GPRS based VPN solutions, besides their staff has been familiarized already with mobile capabilities. The managed service could be offered by this consortium to the Port Authority, which would then sell managed services as a proxy for a supplier consortium, or by the consortium if it got the license and a legal structure. It should be highlighted that the concept of a managed service relieves the end user from up front investments and operations, and allows this end user to “pass on” the cost to his own customers without loading the balance sheet. WLL can also be considered as an access media for on-site cameras etc with a significantly better bandwidth and transmission cost than 3G. Finally should also be mentioned that what brought these parties together was a top-down business concept, i.e. compliance with the ISPS security codes and procedures across the Port of Rotterdam. This consortium is one of the very rare ones to have taken seriously the issue of revenue as well as costs. They also see as a business driver the fact that their customers will perceive that the service supplied is managed for them, the users.

VII. Conclusions

While other such cases exist, such as in the oil and automotive sectors [5], multi-enterprise wireless VPN's demand first organizational and trust issues to be addressed, then costs, and only finally the technical capabilities.

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E-service in the Public Sector

Mehdi Asgarkhani

Faculty of Commerce, C P I T, Christchurch, New Zealand

AsgarkhaniM@CPIT.ac.nz

Abstract: E-technologies are increasingly being recognised as effective tools that can foster an environment of improved service, transparency and improved governance within the public sector. Today, access to information and communication technologies (ICTs) plays an essential role in economic and social development. As public interest in the Internet and e-technology solutions continues to grow, there is an increasing expectation that they will be utilised in national and local governments for more efficient supply and value chain management and for improving public access to information and services. E-technology has become a catalyst for enabling more effective government through better access to services and the democratic process. There is much debate over the role and the value of e-service within public sector organizations. This paper examines the effectiveness of e-services within the public sector with a focus on four specific facets of effectiveness: the view of management and e-technology strategists; social, cultural and ethical implications; the implications of lack of access to e-technology infrastructure; and the customers' (citizens') view of the usefulness and success of e-service initiatives with reference to a case study of a local government e-service initiative within New Zealand.

Keywords: Case Study in E-service/E-business, E-service, Digital Government, E-readiness

I. Preview

The most prominent of the recent advancements in Information and Communications Technology (ICT) has been the emergence of the Internet, Web-based technologies (e-technologies) and global networked economies. Today, e-technologies play an increasingly significant role in our day-to-day lives. They have fundamentally transformed the technological, economical, political and social landscapes.

The competitive imperative of the private sector has driven businesses into the digital world. As a result, the private sector has steadily set higher standards of service (through the application of e-business and e-service solutions) both domestically and internationally. The most significant reform in the public sector has been that of revolutionizing the supply chain management and the value change management through the application of e-technologies.

To deliver the products and/or services in a timely and cost effective manner, the private sector has had to increasingly streamline business processes. The supply chain

is a network of facilities for obtaining raw materials, transforming raw materials into intermediate and/or finished goods, and distributing the final products to markets. Typically, the supply chain integrates manufacturing, distribution, conveyances, retail outlets, people, and information through functions such as procurement or logistics so as to supply goods and services from the origin (source) through to consumption (markets). Supply chain management is considered as the linkage of all the activities that are involved in processes and functions that were mentioned above. It brings together supplier, distributor, and customer logistics requirements into one cohesive function with a focus to reduce time, eliminate redundant functions, and minimize inventory costs.

The value chain is a connected series of value adding processes throughout the production of goods or delivery of services – including: inbound logistics; production operations; sales and marketing; support services and finally outbound logistics. A value chain model can highlight specific processes within the business where the application of e-technologies can impact the business in a strategic fashion.

Digital (electronic) private sector corporations are capable of moving beyond traditional strategic ICT-enabled solutions so as to benefit from digital links with both other organizations and people alike. They can build supply and value chain management systems using Intranets, extranets, or special supply and value chain management solutions. The strategic value of e-technologies in order to enable speedy and cost effective delivery of products and services is outlined in Figure 1.

Public sector organizations deal with complex network of suppliers (and distributor) and sophisticated value chain systems on a daily basis. As public interest in the Internet and e-technologies continues to grow, there is an expectation that they will be utilised in national and local governments (similar to that of private sector corporations). Consequently, many innovative public sector agencies world-wide have had to create new ways in which to use e-business and e-service solutions (known as electronic or digital government) so as to enhance citizens access to information and services, improve the efficiency of processes within business units and establish more productive relationships with both citizens and private sector agencies alike.

The introduction of e-service solutions within the public sector has primarily been concerned with moving away from traditional information monopolies and hierarchies. What's more, e-service and e-business (through digital government) have fundamentally transformed the ways in which the logistic processes and supply chain dynamics are managed

within the public sector. However, e-service remains a challenge to both citizens and public sector agencies alike. Governments must not only maximize the benefits that are offered (through the application of digital government and e-service) but must also avoid the many pitfalls (economical, social and cultural) associated with rapid technological change. That is to say, even though ICT-enabled government and e-service have become a catalyst for better government, the challenges to effective government within today's knowledge society are profound.

Figure 1. The Strategic Value of e-Technologies

Efficiency	
Time	Accelerating business processes and activities
Distance	Reducing geographical and distance inhibitors/barriers
Creativity	Enhancing existing business processes and activities
Effectiveness	
Time	Improving the flow of information and business intelligence throughout the supply and the value chain components
Distance	Enabling integrated control of the supply and the value chain processes
Creativity	Enabling new (and/or modified) processes
Growth	
Time	Obtaining early market entry/presence
Distance	Introducing new products to new markets
Creativity	Developing new products and services

Recently, there has been much debate over the value and effectiveness of e-service within the public sector. This paper elaborates on the strategic role, the value and the effectiveness of digital government that enables e-service. Four specific facets of effectiveness have been examined:

- Effectiveness from the point of view of management and ICT strategists (concerning the implications of ICT and e-service in the public sector).
- Effectiveness as it concerns social, cultural and ethical implications of e-service and e-business.
- Effectiveness with reference to differences in access to ICTs (digital inclusion/exclusion).
- Effectiveness from the point of view of citizens - a preliminary study of the citizens' view of e-service and e-business.

The paper is presented in two parts. Part one (based on a review of previous studies and analysis of digital government and e-service cases such as: [2], [3], [4], [5], [6],

[7], [10], [12], [13], [14], [18], [20], [22] and [35]), reviews the fundamental concepts of digital government and e-service followed by discussing the effectiveness as outlined in (a), (b) and (c).

Part two of the paper is based on a case study of a digital government and e-service project within the Canterbury region of New Zealand. The case study examines the effectiveness of e-service, efficiency of logistic processes and relevance to e-technologies as outlined in (d). The methodology for gathering information included interviews with project sponsors (and a number of other stakeholders) and a combination of formal interviews and surveys of several focus groups of users.

II. Digital Government and E-service: An Overview

This paper views the term 'governance' as a guiding process for decision-making and managing day-to-day activities and interaction with one another (within organizations, groups or societies). *Digital Governance (e-governance)* is a term used to emphasize the application of Information and Communication technologies (ICTs) in governance systems and processes. *Digital Government (e-government)* is the use of ICTs in general and Web-based technologies in particular, in order to: promote and motivate a more operationally efficient and cost-effective government; facilitate more convenient government services (and information) to citizens and businesses; enhance economic development; reshape and redefine community and government processes; and make government more accountable to their citizens. Digital government often consists of digital service delivery, digital governance and digital democracy.

E-Service refers to solutions and processes that allow electronic delivery of services (such as providing information, consulting, support, initiating processes – to name but a few) mostly through digital government/ governance initiatives. *E-Service* (in public sector) as discussed in this paper is closely associated with digital government initiatives.

Technology is the backbone of the required infrastructure that supports digital government. Yet there is a danger in placing too much emphasis on technology. Technical innovation on its own is not enough to drive the development of digital government and e-service solutions.

The political and financial support for e-service can be accompanied by rhetoric and hype. It is fair to say that the potential benefits of digital government and e-service can only materialize when initiatives are introduced as part of a well-planned and properly supported social and cultural environment. There is also a need for considering tools and metrics (performance measures) in order to not only assess progress and effectiveness on an ongoing basis, but also to ensure that rhetoric of e-service is matched by reality.

E-service and digital government/governance is not primarily a technical exercise, but rather an attempt to improve the political and social environments and to introduce a fundamental change in the ways in which public

sector functions (e.g. value chain and supply chain processes) are performed. The essence of government centres on relationships. Hence, an effective model for developing digital government solutions needs to view digital government and electronic delivery of service to citizens as a hub whereby e-technologies are introduced so as to interconnect the various domains of governance.

Extensive research has been carried out (by various practitioners and advisory/interest groups such as the International Centre for e-Governance – www.icegov.org) in order to examine the right level of integration of governance domains and the role and capacity of government (e.g. [4], [3], [24], [25], [22], [26], and [29]). Overall, there can be no one particular answer that can address all cases of e-service and digital government across the board.

As the application of ICT and e-technologies in the public sector within the developing nations becomes widespread ([3], [4], [35] and [29]) we begin to observe a progression through the various stages of digital government that enables e-service:

- **Stage 1** - Improving internal functional efficiency through the application of ICT.
- **Stage 2** - Improving internal communications (through the application of electronic mail) and introducing workflow management systems for increased process efficiency.
- **Stage 3** - Providing access to information with regards to services and the democratic process (initial stages of enabling public/social inclusion).
- **Stage 4** - Putting in place applications that would not only enable citizen participation through feedback, but would also allow for transactions between citizens to government (C2G), businesses to government (B2G) and government-to-government (G2G).
- **Stage 5** - Introducing digital democracy – technological solutions that would enable participatory action and democratic processes.
- **Stage 6** - Introducing integrated electronic or digital governance.

III. What Motivates E-service within the Public Sector?

Overall, the public sector's view (national or local governments) of e-service through the introduction of digital government initiatives is likely to include:

- Automating government systems and the online delivery of services
- Adopting network-based technologies and migrating government functions to the Internet
- Introducing electronic capabilities and practices to government so as to reduce costs, reduce fraud, and increase efficiency
- Adopting ICT so as to foster economic growth and

conduct business

- Improving (re-engineering) the structures of government and the nature of public administration
- Adopting ICT to foster constituents' engagement, improved political accountability, and e-democracy

Local governments (e.g. see [30], [5]) seem to concentrate on:

- *Prompt, accurate service* – Local governments can potentially receive millions of calls per year. Resolving a high percentage of these calls the first time they occur can result in significant efficiency gains and cost savings.
- *Improved quality of service* - One client of a local government can potentially generate up to dozens of files in different locations. Local governments are seeking to convert these to one secure and accessible file in order to help provide continuity and coordination of local government support.
- *Removing barriers and tackling social exclusion* – Local governments are aware that many clients do not have the skills to use electronic services. Local government agencies need to set up networks of learning centres in community centres so as to teach people the relevant Web technology skills.
- *Local access points* – It has been shown [30] that up to 20% of customer queries cannot be addressed immediately. Clients often need to meet with a “professional.” Local governments can benefit from the setting up of community access points to allow clients to meet ‘professionals’ through online video links.

Figure 2. Forces That Motivate e-Service through Digital Government

Driving Force	Average Score 5: Essential 0: Not important
Perceived benefit to local people	4.3
Authority's strategy	4.1
Influence of officers	4.05
The need to modernise services	4
Influence of members	3.7
Best value	3.5
Central government initiatives	3.5
Potential cost savings	3.3
Influence of suppliers	2.9

A survey of potential motivators of digital local government and e-service [30] indicates that *improving service to constituents* is rated as being the most important factor (Figure 2).

IV. Effectiveness of E-service: the View of Strategists and Thechnology Practitioners

The influence of strategists and practitioners' view on public perception of digital government can impact upon the successful implementation of e-service initiatives.

A review of various viewpoints over the implications of digital government (e.g. [3], [5], [35], [9], [19], [23], and [34]) indicates that there are at least four schools of thought:

- pure optimism
- optimism with some concerns
- pessimism
- technology viewed as a tool only - but not a driving factor on its own

The optimists argue uncompromisingly that the use of technology in governance represents a major once-and-for-all improvement in the capabilities of governance ([23], [21] and [35]). The only cost is considered to be the investment on the ICTs and the day-to-day operational costs. This optimistic view appears to be based on the classical cybernetic theory [32].

The second group accepts at least the possibility of greater control, quality and rationality in decision-making. However, they argue the efficiency gains through digital government come at a price. They believe unless safeguards are put in place, digital government may result in compromising citizens' rights such as:

- the right to individual liberty and privacy
- the right to influence governmental decision-making ([35] and [19])
- losing control over politicians' decision-making agendas [34]

The pessimists argue that the application of technology in government will actually compromise the quality of decision-making. They are concerned that excessive demand for policy analysis based on many categories of information will cause delays in action – “paralysis by over-analysis.” There is a fear that due to mechanical rule following, overly simple modelling, the cultivation and the exercise of judgement in decision-making will be downplayed.

The followers of the last school of thought view technology as a tool and argue that the impact of ICT solutions and e-technologies cannot be viewed in isolation. They view both continuities and changes in governance as being driven socially and politically, and not by technology itself. Technology is seen as a tool for either changing or preserving the styles of governance (e.g. [15] and [11]).

Each theory that has been mentioned above has some empirical support - although most empirical studies have been of a rather limited scope and are not in general designed to test, let alone falsify these rival theories.

Overall, accepting any of these viewpoints as being applicable to every case concerning e-service and digital government would be unrealistic. The viewpoint(s) that can best describe the parameters that influence digital government and e-service strategies depends on numerous factors - such as social and cultural aspects; the

technological infrastructure; past experience with the application of ICTs; the level of education and interest in the political process, to name a few.

Some other social, cultural and ethical aspects of ICTs and e-technologies that may hinder the rollout of e-service (and digital government) initiatives can include:

- concerns on individuals' rights and privacy
- concerns over information security
- impact on jobs, workplaces and social interaction

V. E-Readiness: Access, Availability and Affordability of E-technologies

Today, access to e-technologies and ICT is critical for economic and social development. Some international organizations including the International Telecommunication Union (ITU) have been making efforts to bring together policy makers in order to agree upon commitments to strategies towards socially and digitally inclusive societies worldwide. In 2003, the World Summit on Information Society (<http://www.itu.int/wsis>) organized by the ITU made progress towards establishing an agreed upon set of strategies to enhance social inclusion (access, availability and affordability).

There is much optimism that we are facing myriad of digital opportunities where the means exist to broaden participation in the network-based economy and to share its benefits. At the same time, differences in diffusion and the use of ICTs and electronic networks appear to be deepening and intensifying the socio-economic divisions amongst people, businesses and nations. This phenomenon (known as the *digital divide*) can lead to: divides between countries; social divides within countries (related to income, education, age, family type, and location) and business divides (related to sector, region, and firm size).

A review of some of the studies concerning *digital inclusion/exclusion*, *digital divide* and *e-readiness* (e.g. [28], [1], [7], [8], [12], [16], [29], [33], and [27]) indicates that there are significant differences in the adoption of ICTs, network economy and digital government worldwide. This section of the paper outlines a small sample of these studies.

META Group [16] examined the digital commerce (e-commerce) competitiveness of 47 countries. According to the author of this study (Howard Robin), “Traditional industrial-age measures of production and performance have lost relevance in the information age. Currently, information processing capability is a better indicator of national competitive advantage.”

The research by the META Group ranked 47 countries in five different categories in order to establish an overall ‘*information age technological competitiveness*.’ These categories included knowledge jobs; globalisation; economic dynamism and competition; transformation to digital economy; and technological innovation capacity. The results confirmed differences in the adoption and the use of ICTs and electronic networks within the countries that were studied.

The first fifteen countries in the overall ranking of ‘*information and technological competitiveness*’ included: the USA, Japan, Germany, France, Finland, Canada, the United Kingdom, Australia, the Netherlands, Taiwan, New Zealand, Belgium, Spain, Sweden and Hong Kong (SAR).

Information Society Index (ISI) involved 23 parameters in its study of the use of ICTs and e-technologies within 150 countries [27]. The study concluded that 55 out of 150 countries accounted for 98 percent of the total ICT resources. The top 55 countries were classified under four categories – including:

Skaters – countries with advanced ICT and social infrastructures.

Striders – countries that appear to be moving purposefully into the information age, with much of the necessary infrastructure in place.

Sprinters – countries that are moving forward in spurts before needing to catch their breath and shift priorities due to economic, social and political pressures.

Strollers – are those moving ahead but inconsistently, due to limited financial resources in relation to their vast populations.

The ‘skaters’ were: Sweden; Norway; Switzerland; the USA; Denmark; the Netherlands; the United Kingdom; Finland; Australia; Taiwan; Hong Kong (SAR); Japan; Singapore and Canada. Figure 3 displays the summary of ISI research.

A survey of online governance conducted by UNESCO [29] outlines a number of key inhibitors to the successful implementation of digital government and e-service initiatives – see Figure 4.

Numerous other studies (e.g. [29], [30], [5] and [5]) indicate that many other factors can hinder the successful introduction and effectiveness of e-service digital government solutions – some of which are outlined in Figure 5.

A relatively small sample of research outcomes cannot be applied to all countries/regions. However, it appears that many countries are at the initial or halfway stages of adopting Web-based solutions in order to introduce e-service.

It is fair to say that unless the barriers to access, availability and affordability of ICTs within nations are addressed, the success of *bringing to reality the vision of e-service through digital government* would be limited. The causes of digital divide can limit the successful implementation of digital government.

VI. E-service in Local Government: A Case Study

One of the parameters that can potentially impact upon the successful introduction of e-service would be that of the public’s view (sometimes based on previous experience from digital government solutions) of the effectiveness of

digital government. To date, there appears to be little evidence of the citizens’ view of digital government that enables e-service. This section is based on a case study that examines the users’ view of a digital government initiative within New Zealand.

New Zealand’s e-government strategy (<http://www.e-government.govt.nz>) emphasizes the role of the Internet and e-technologies as the dominant means of enabling ready access to government information, services and processes. This strategy envisages the implementation of a single ‘one-stop shop’ portal to all New Zealand government services that are seamlessly integrated with the government’s back office – comprising of the Inland Revenue Department, social services agency, local bodies and a number of other government departments.

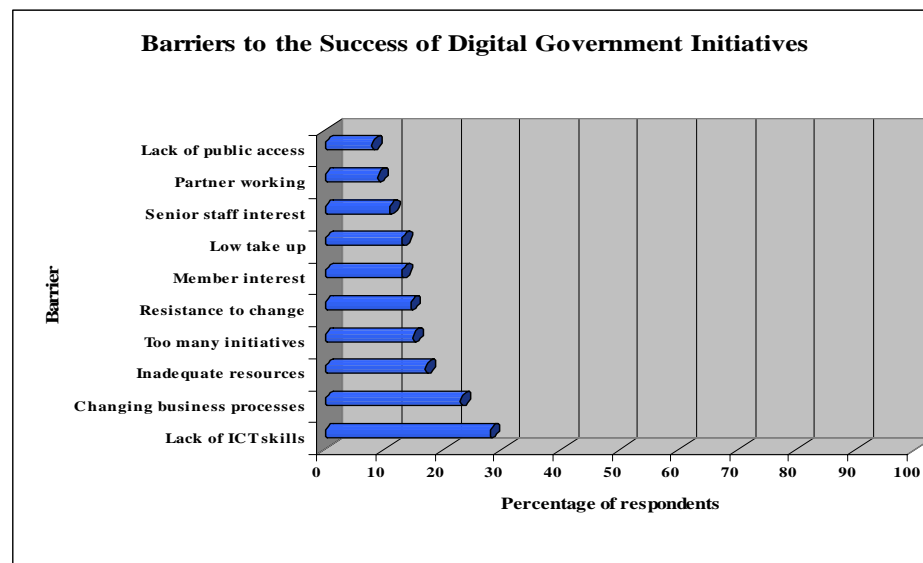
Figure 3. ISI 2002 Summary by region

REGION	SKATERS	STRIDERS	SPRINTERS	STROLLER
North America	14.3%	-	-	-
South America	-	-	7%	23%
Europe	50%	75%	31%	7%
Australia	35.7%	16%	6%	38%
All other regions	-	9%	19%	32%

Figure 4. e-Service Inhibitors

The key inhibitors to the development (or effectiveness) of digital governance/government in developing or underdeveloped nations	Percentage of Respondents
Lack of infrastructure	60%
Lack of resources	47%
Low level of ICT literacy	33%
Lack of awareness at policy level	20%
Low public incentives	27%
Low Internet penetration	20%

Figure 5. Barriers to Success of e-Service through Digital Government



The approach to electronic (digital) government and e-service within the New Zealand local government has been a collective integrated strategy – by establishing the New Zealand Local Government Online in 1997 (<http://www.localgovt.co.nz/LGOL>). Local Government Online Limited (LGOL) is a joint initiative of the Society of Local Government Managers (SOLGM) and the Association of Local Government Information Management (ALGIM). LGOL, owned jointly by SOLGM & ALGIM, owns the Website and offers Internet related services to the local government sector. These services are developed and operated under a collaborative approach that engages economies of scale in order to achieve cost and operational efficiencies and to encourage an integrated approach to the re-engineering of the supply and the value chain. LGOL's current mission is "to help local government transform into e-local government through innovative leadership and by providing leading-edge services and facilities."

The Website receives over 280,000 requests for information each month and mailing lists provided with services for Councils generate in the vicinity of 45,000 email enquiries and responses within the sector each week. LGOL offers the product 'Community On Line,' a template website carefully crafted to meet the e-government requirements of a local authority. Economies of scale have been engaged in order to be able to offer this product at a "cannot be refused" price with a monthly hosting and development charge to allow for continuing development and expansion into the e-commerce area. LGOL has established itself as the pre-eminent provider/facilitator of Internet services to the New Zealand local government with the Website acting as the primary portal to all local governments within New Zealand.

This pilot study (case study) of e-service from the users' viewpoint was conducted after a review of a number of digital government cases (e.g. see [2], [5], [7], [14], [18],

[20], [31] and [17]).

In developing and rolling out e-service initiatives, it is essential to develop performance measures in order to assess progress, effectiveness and success. Performance measures should be developed with stakeholders' input and should be documented and communicated to all parties involved. Performance measures can include: financial parameters (e.g. ROI), productivity factors and citizens' satisfaction (better service), to name a few. This section of the paper concentrates on the citizens' view of effectiveness with reference to the results of the study mentioned in Part (b) above.

As mentioned earlier, this section is based on a digital government and e-service project within the Canterbury region of New Zealand. This project reflects the trends in local governments worldwide - in the development of e-technology solutions so as to enhance communication and the information flow between governments and their citizens. The key objective of this particular project is to facilitate improved two-way exchange of information and to enhance its public image as a professional customer service oriented organisation.

The local government that initiated the project (referred to as the Council hereafter) seems to be conscious of distinguishing between political rhetoric and the reality of digital government – as demonstrated through measuring the success of the project on an ongoing basis. The performance measures that have been considered include:

- Website hits – which are monitored on an ongoing basis so as to determine the utilization of services
- Customer feedback through the service web sites
- Quantifiable efficiency benefits (e.g. cost savings, time savings, and service level impact and so on)

Overall, *Web-site hits* are not an effective measure of

usefulness and usability of a web site – unless it is combined with statistics concerning the number of users who actually proceed to access services past the *home page*. *Customer feedback* through service websites can be a more effective measure of user satisfaction. However, it would be beneficial to include feedback from other sources (e.g. phone calls). *Quantifiable efficiency benefits*, as a measure of success does not directly reflect public access to e-service.

A review of the electronic services delivery site indicates that the Council is an example of Stage 4 of the progression of digital government initiatives (as discussed in Section “Digital Government and e-Service: An Overview”).

E-services (and information) provided on the web site can be seen as being placed in two categories:

Providing Information:

- Current issues of significance (Hot Topics) – e.g. area plans, recent policy changes, annual report(s)
- General information with regards to services – rates information, street maps, rubbish collection, projects in various areas, jobs at the Council, forms, weather, library catalogue, Art Gallery, bus timetables, leisure centres and the link to govt.nz
- Specific Council information – about the mayor, councillors, community boards, council meetings, meeting agenda and proceedings, public notices, and newsletter
- Events – events calendar, tourism and visitors’ information, online guide to the city, clubs and groups

Communication and/or feedback:

Contact the Council, Ask us, Quick Answers and Have Your Say (feedback RE council projects)

A survey was conducted in order to assess public awareness and their views of the Council’s electronic service delivery initiatives. Sixty one percent of the participants were between 18 and 34 years, 26% were between 35-49 years and the rest were aged 50 years and over. It appeared that 76% of the respondents were aware of the digital governance services that are provided by the Council online.

Approximately 87% of the respondents who were already aware of the Council’s online services and 81% of those who previously did not know of the Council’s web site considered access to online services as being helpful.

It appeared that the majority of respondents (49%) were aware of the Council’s website through word of mouth – followed by Web surfing or search engines (32%) and advertising (19%).

Respondents seemed to have accessed library information, agencies’ hours of operation, and events in the city and city maps more frequently than other online information – as seen in Figure 6.

As you can observe from Figure 7, immediate access to information anytime and anywhere appeared to be the most important reason (77%) for the perceived usefulness of the Council’s digital government and e-service initiative.

On the issue of difficulties in using the Council’s web

site, 32% found the link to be slow whilst 8% could not locate the relevant information and 7% found the navigation to be complex.

Figure 6. Frequently Accessed Information

Type of Information Available	Percentage of Respondents
Library information/catalogue	42%
Services - hours of operations	38%
Events in the city	32%
Maps	31%
Community services/events	30%
Rates information	25%
Bus timetable	23%
Permits	13%
Art Gallery	12%
Job advertisements/applications	11%
Water resources	10%
Population statistics	7%

Figure 7. Reasons for Effectiveness

Reason for Effectiveness	Percentage of Respondents
Immediate access to information anytime/anywhere	77%
Time saving - no need for time consuming telephone calls and/or visiting the Council	55%
Access to relevant information with reasonable details (yet simple to follow)	40%
High level of usability	27%
Links to relevant pages/sites	25%
Easy to navigate	20%

Figure 8. Future e-Services Requested

Desired Online Services	Percentage of Respondents
Rate payments	37%
Online submission of applications (e.g. building permits, resource consents and so on)	30%
Multimedia streaming of local events	30%
Fee payments	27%
General Council related information	25%
Online voting facilities	23%
Interactive online services such as discussion groups and online forums	23%
No reply	6%

Many respondents expressed an interest in enhancing (broadening) the Council's online services to include rate payments and online transactions – as outlined in Figure 8.

Participants were asked to state their concerns about using online services. Results show data security is the greatest concern for customers (71%) – followed by concerns about confidentiality of data (66%); lack of appropriate technical infrastructure (24%); and document incompatibility (6%). It has to be noted that 19% of the participants expressed no concern at all in using online services.

The respondents rated the contents of the Council's e-service web site as 7.18 (out of 10 – with 10 being highly desirable). The quality of services that are being made available online was rated at 7.52. The rating for the value of access to online services in the public sector in general was 6.93.

In brief, even though the results of this pilot study are not to be considered as final, it appears that this particular e-service initiative is rated favorably.

It would appear that there is support for carrying out future digital government and e-service strategies based on the experience users have had from the Council's existing electronically delivered services. However, it should be noted that these results cannot be viewed as being applicable to other e-service solutions that are being provided in other countries.

VII. Summary and Conclusions

Within the past few years, much has been debated over the key factors that would impact upon the implementation of digital government and e-service strategies. Overall, practitioners and management scientists tend to agree that the trend for government transformation through e-technologies is irreversible. Yet there is also a danger. Technical innovation on its own is not enough to drive the development of e-service and digital government solutions. The potential benefits of e-technologies for improved service and better government can only materialise when the solutions are introduced as part of a strategically planned process, adequately supported environment for both citizens and businesses alike and with a focus on locally relevant objectives. Successful e-service initiatives through digital government need to:

- encompass the improvement of service delivery to the citizen, the creation of economic activity and the safeguarding of democracy.
- be orientated towards the citizen. The citizen does not need to be aware of who in the government provides the required service. That is to say, inter-agency and intergovernmental e-governance dimensions are essential.
- be made available to all citizens (not just to a minority who can afford to have access to the required electronic infrastructure).

- provide an opportunity for business process re-engineering of supply and value chains – merely automating existing services is inadequate and does not necessarily produce satisfactory results.
- provide opportunities to build viable and sustainable partnerships between the private and the public sectors – where each party would be responsible to provide e-capacity in order to achieve a competitive advantage.

This paper examined some of the parameters that influence the successful implementation of effective e-service and digital government solutions – including:

- The view of management, theoreticians and ICT practitioners with regards to the implications of digital government and e-service – ranging from the optimists who view digital government as being an effective tool (without any concerns) to those who view technology as a tool only (arguing that technology on its own cannot be a driving force for service effectiveness).
- The implications of the digital divide and e-readiness – the success of carrying out digital government strategies in a country rely on its state of digital readiness and the ways in which the barriers to the *digital divide* can be overcome.
- The citizens' view of experience with e-service initiatives – a pilot study of digital government within the Canterbury region of New Zealand indicated that local citizens rate digital government and e-service solutions as being effective. However, these results are not final and cannot be taken as being applicable to other digital government solutions introduced in other countries/regions.

In conclusion, access to the right technology for delivering e-service in the public sector is essential but insufficient. Even though most of the shortcomings (as they concern the effectiveness of digital government) can be resolved by improving the technology infrastructure, technology by itself does not necessarily result in better, more efficient, and service orientated government. Technological advancements are only effective if they are considered alongside other key parameters such as social structure; cultural values and attitudes; ethical considerations; business process re-engineering and the political culture within the public sector.

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E-business in Lithuania Transport Sector: Current Situation and Challenges Ahead

Rimantas Gatautis¹, Panagiotis Damaskopoulos², Philip Seltsikas³

¹ Electronic Business Research Center, Kaunas University of Technology, Kaunas, LT 44309, Lithuania Rimantas.Gatautis@ktu.lt

² European Institute of Interdisciplinary Research, Paris, 100084, France Takis.Damaskopoulos@eiir.org

³ University of Surrey, School of Management, Guildford, GU2 7XH, UK P.Seltsikas@surrey.ac.uk

Abstract: Lithuania has a well-developed transportation system. Its geographically strategic position is very important to European transport corridors. In Lithuania, there are various important factors that contribute to shaping the sector's characteristics — lack of knowledge, a low level of computerization and Internet usage — that cause 'e-business possibilities' not to be used. An appropriate analysis of effective e-business usage for the development of competitive advantage between transportation companies is a very important task which requires theoretical grounding and research of practical possibilities. The purpose of paper is to analyze the use of e-business in Lithuania's transportation companies. The survey was supposed to act as a guideline to the future of Internet usage in the Lithuanian transportation industry. The survey tried to find out considerations about the Internet, how it had affected their business and activities and what might happen in the future.

I. Introduction

Lithuania has a well-developed transportation system. Its geographically strategic position is very important to European transport corridors. The EU's Transport Commission has designated Lithuania as the region's transport hub, with 2 out of the 10 priority corridors in Europe intersecting Lithuania. A network of European-standard 4-lane highways link major industrial centres. Road construction is underway for connecting with the Trans-European transportation network. It will be part of the transportation system around the Baltic Sea and a transportation axis linking Russia and the Baltic Sea. The country offers 4 international airports and an ice-free port on the Eastern Baltic. In this context Lithuania's transportation facilities play an import role in the country.

Considerable attention is paid to the development of transport and communications through Government approved programmes. One of the basic provisions of this programme is to create a long-term strategy for the development of different transport sectors within the national transport system to meet core strategic objectives of the European common transport policy. The use of ICT and e-business in transportation companies allows them to offer more competitive services to their consumers.

ICT based e-business can influence logistics and transportation activities. There indications that development in information technologies have reached a level of maturity

where with available systems there are little constraints on what may be possible to achieve in logistics. Despite the availability of advanced information systems and technologies for use in the sector, there remains the issue of knowledge for using these. 'E-business' can be considered as one of those tools (Persson, 2003).

Problem. *This article is focused on the study of the role of e-business in Lithuanian transport sector enterprises. The new opportunities for companies, which can be achieved by using e-business become vitally important for competing in the market. In Lithuania, there are various important factors that contribute to shaping the sector's characteristics — lack of knowledge, a low level of computerization and Internet usage — that cause 'e-business possibilities' not to be used.. An appropriate analysis of effective e-business usage for the development of competitive advantage between transportation companies is a very important task which requires theoretical grounding and research of practical possibilities.*

The purpose of research. *The purpose of the research reported in this paper is to analyze the use of e-business in Lithuania's transportation companies.*

II. The Internet and E-business in Logistics

In most cases, e-business and e-commerce has been focused on the fulfilment of customer orders and the distribution process. It was, and still is, believed that e-business and the increased connectivity of the Internet will give rise to new customer behaviour and that this will have serious implications on the whole industry. This has been confirmed from various sources (e.g. Lancioni et al., 2000; Barua et al., 2001; Javalgi and Ramsey, 2001). In an investigation from 2000 it was concluded that the most popular use of the Internet for supply chain management was in transportation, followed by order processing, managing vendor relations, purchasing procurement, and customer service (Lancioni et al., 2000).

More sophisticated customer demand chains and e-business processes pose new challenges to logistics service providers. Research & development into new logistics service concepts are required regardless of the line of business both in B2B and B2C environments. Unless products are non-material, physical distribution logistics is one of the key challenges for the supply networks of e-marketplaces. The development of effective e-business processes will increase the importance of particularly delivery accuracy, delivery frequency and delivery time.

A prerequisite for effective relations is the extensive use

of information technology. Partnering would never have emerged in its present potent form without the explosion in information technologies, which enabled companies to merge critical elements of their business systems with relative ease and speed. Only then could they capture the efficiency and effectiveness benefits of tearing down the boundaries between firms. The Internet is an ideal medium to use as a backbone in any partnership. An example of a company that has structured its relationships around the Internet is Dell Computer Corporation.

E-business opens up an entirely new market for actors in the logistics field. Logistics and distribution systems that function efficiently and effectively in all respects will be crucial for the success of the companies involved. This implies that manufacturing companies, and especially logistics companies, must identify and create effective logistics solutions in order to compete in the marketplace.

III. Research Results

The empirical research carried out among Lithuania's transport companies has been conducted using questionnaires. A questionnaire was sent to Web-present Lithuanian companies in this industry. The purpose of the survey was to investigate how transportation companies use the Internet and what sort of problems it brings. A total number of 113 respondents participated in the survey. The survey was supposed to act as a guideline to the future of Internet usage in the Lithuanian transportation industry. The survey tried to find out considerations about the Internet, how it had affected their business and activities and what might happen in the future. The survey also intended to find out the purpose of respondent companies Internet investment, which individual was behind it and what problems it brought.

The results show that most of the enterprises surveyed use e-business rather recently, only 21% of enterprises participated in the investigation use e-business for more than three years. 30 % of enterprises use e-business less than one year and 49 % - for 1-3 years. Thus e-business in Lithuania is rather young phenomenon and this fact largely influences these results.

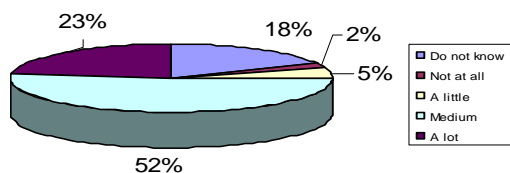


Figure 1. Internet effect on companies activities

The companies in the survey were asked questions on how the Internet has affected their company or what kind of changes it has generated. 75 percent said that the Internet

had affected internal communication to a 'medium'/'a lot' extent. Contacts with customers, suppliers and partners also seem to have been greatly affected. However, the Internet does not seem to have influenced either profit nor competitive advantage or development of new products/services so far. These results indicate that most companies have not fully begun to use the Internet's advantages, i.e. for more than as a communication tool.

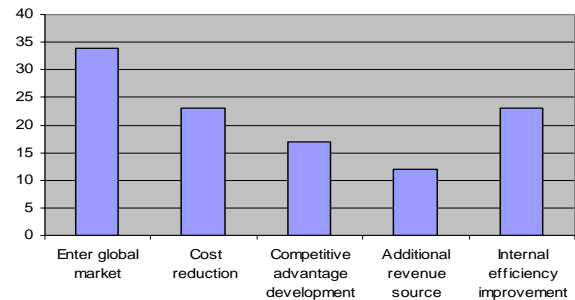


Figure 2. Objectives of e-business decisions

Companies participating in the survey were also asked to evaluate the Internet and e-business influence on the future company's activities. Many companies reported that communication, both internal and external, to be greatly affected by the Internet. Moreover, many companies see the potential with of Internet as a communication tool. Moreover, 61 percent believe that it might generate new customers and reach new markets. The Internet is also perceived to affect the development of new product/services as well as giving a higher quality of service. However, it is noteworthy that many companies think it will greatly affect profits – 61 percent believe profits will be affected to a medium extent or a lot while 37 percent think a little or not at all.

Less than half of the companies in the survey have an Internet strategy while the other half has none. On the other hand, in most companies Internet-related issues are often discussed at a top management level, 41 percent do this to a medium extent or a lot compared to 42 percent who do not discuss these issues at all or just a little. This leads us to believe that many companies have now realized that the Internet will have future impacts on the industry. Only few companies have a special e-business department – only 11 percent compared to 89 percent who have not. However, many perceive the Internet to be a natural part of future strategies as well as an important tool for establishing future competitive edge.

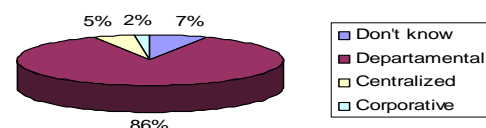


Figure 4. Level of e-business solutions

In few enterprises surveyed e-business solutions are accepted and implemented in a centralized way, i.e. decisions for e-business use, objectives, technologies selections etc., are made by the top management. A large proportion of the enterprises state that e-business solutions do not cross boundaries of division, department or section. Thus in order to achieve higher development stage enterprises should pay particular attention to e-business decision-making and the implementation of systems. The most important aspect in this respect is that not only one department or division, not only top management, but all employees of an enterprise should be involved into the decision-making and implementation of a company's e-business.

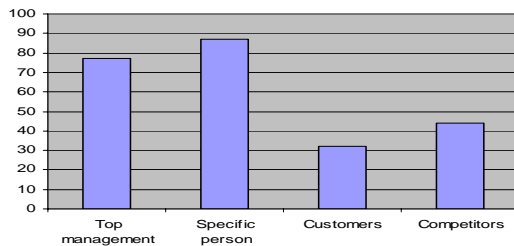


Figure 4. E-business investment drivers

It appears to be top management or individual persons that are prime movers for an Internet investment. 77 percent answered that top management was the driver, which gives an indication that the Internet is considered to be of importance for the industry. However, more said that a specific person had had a great influence on the investment. However, only 44 percent said that competitors activities greatly influenced the Internet investment with 20 percent claiming they had a medium impact.

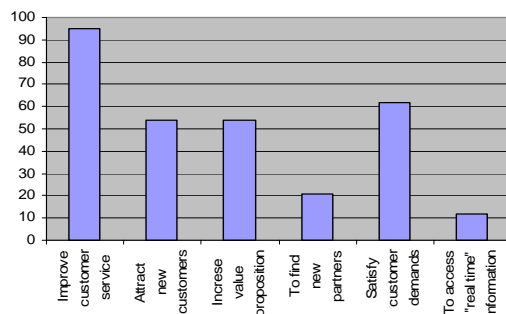


Figure 5. Marketing activities improvement using e-business

Internet investment is primarily seen as a marketing tool and as a tool to improve customer service. A total of 95 percent thought this to be of importance. 54 percent also claimed that the investment was supposed to attract new customers as well as increasing the value of existing services. However, it does not seem to be of interest in the industry to partner with online companies. Only 29 percent claimed partnering to be of medium interest or very interesting while 79 percent thought it was of little or no interest. Instead, 62 percent said that they had invested in the Internet in order to satisfy customer demands.

Many discussions about the Internet concern security

and complexity issues and one could assume that many companies would consider these to be some of the major problems with their the Internet investment. The majority of the companies in the survey did not seem to share this apprehension; instead 63 percent claimed that an obstacle was the difficulties with measuring the effects of the investment. Moreover, half of the companies said the customers did not request it while the other half claimed they did. In general, no particular problem was emphasized.

IV. Conclusions

Summarizing the research results, it can be stated that thus far the Internet has primarily been perceived as a communication tool, both for internal as well as external use in the Lithuanian transportation sector. This is also regarded to be of considerable future importance though the companies also see e-business solutions as a way to attract new customers. Another field of application for e-business is marketing as well as a tool for development of new products and/or increasing their values. Only half of the companies in the survey seem to have a specific Internet strategy whereas the other half has not. However, for a majority of the companies surveyed, Internet related issues are often discussed at a top management level leading us to believe that the industry has realised the importance of e-business to their sector. Most companies consider the Internet to be a natural part of future strategies and a significant contributor to future competitive advantage.

For most companies, the prime movers for an Internet investment have been either top management or a specific person at their company. The purpose of the investment was to attract new customers, improve customer service, and increase the value on existing services, sales and to satisfy to customers' expectations. However, not as many respondents as expected claimed the purpose of the investment to be efficiency improvements. The majority of the companies did not appear to have any specific problems with their e-business investment.

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Identifying Micro Projects for Improvement of E-Readiness of Sri Lanka

Velauthapillai Dhayalan *, Reggie Davidrajuh **

* Computer Science, Bergen University College, Norway, vdh@hib.no

** Electrical & Computer Engineering, University of Stavanger, Norway, Reggie.Davidrajuh@tn.his.no

Abstract: This paper focuses on identification of micro projects for improvement of e-readiness of Sri Lanka. First, the proposed strategy by the Government of Sri Lanka is presented. Second, from the proposed strategy, requirement analysis is done to draw a set of requirements, using two approaches: a) E-readiness measurement, b) System analysis using the theory of connection. Third, from the requirements, a set of projects are identified that can improve e-readiness of Sri Lanka; though different types of projects are identified, emphasis is given to micro projects that are people-centric, low-cost, and sustainable.

Keywords: E-government, e-Sri Lanka, e-readiness, micro projects.

I. Introduction

In November 2002, the government of Sri Lanka launched *e-Sri Lanka* – the information and communication technology development roadmap to achieve e-governance by the year 2007. According to the official document, the main purpose of e-Sri Lanka is to achieve the desired levels of development by enhancing national competitiveness, and to reduce or eradicate poverty by realizing enhancements in the quality of life of its citizens [5]. The government of Sri Lanka believes that the vision will take the dividends of information and communication technology (ICT) to every village, to every citizen, to every business and also transform the way Government works. However, studies show serious shortcomings in the proposed strategies [4]. Studies also reveal that proper measures for improving e-readiness of Sri Lanka has not been identified or put into practice [4].

The main purpose of this paper is to identify micro projects that can improve e-readiness of Sri Lanka. To do this, a scientific approach is used in this paper that consists of four steps: First, the proposed strategy by the Government of Sri Lanka is presented; this serves as the needs analysis. Second, from the proposed strategy, requirement analysis is done to draw a set of requirements; this is done using two approaches: a) E-readiness measurement, b) System analysis using the theory of connection. Third, from the requirements, a set of projects are identified that can improve e-readiness of Sri Lanka; though different types of projects are identified, emphasis is given to micro projects that are people-centric, low-cost, and sustainable.

The uniqueness of this paper lies in the scientific

analysis of the proposed strategies for e-Sri Lanka in order to identify the projects that can be implemented to raise the e-readiness.

Structure of this paper: Section-2 presents the need analysis; in this section, the proposed strategy for e-Sri Lanka is presented. Section-3 presents the requirement analysis, analyzing the proposed strategy. Section-4 identifies the micro projects that can give a lift to e-readiness of Sri Lanka.

II. Need Analysis

This paper starts with the need analysis for e-Sri Lanka, as the authors believe that any system cycle or system engineering process should begin with the identification of a need based on a want or desire for something arising from a deficiency [1]. The need in this case is the gap between current and desired (or required) level of e-readiness or the gap in results between what is now and what should be after (successful) completion of e-Sri Lanka. Needs analysis is a process of determining the reasons and causes for a need so that appropriate interventions may be identified and later selected.

Rather than using surveys, questionnaires and interviews for the needs analysis, we present or restate the government of Sri Lanka's strategy for e-Sri Lanka. However, the strategy is presented in a highly intelligible format so that requirement analysis and implementation can be done in later sections.

II. 1 The Needs Assessment

In November 2002, the government of Sri Lanka launched *e-Sri Lanka* – the information and communication technology development roadmap to achieve e-governance by the year 2007. Sri Lanka's first ever e-government conference was held in May 2003. The event was given utmost importance by the government of Sri Lanka, and was supported by some of the inter-governmental organizations such as the United States Agency for International Development (USAID) and the Swedish International Development Agency [9].

According to the official document, the main purpose of e-Sri Lanka is to achieve the desired levels of development, by enhancing national competitiveness, reduce or eradicate poverty by realizing enhancements in the quality of life of its citizens [5]. The government of Sri Lanka believes that the vision will take the dividends of information and communication technology (ICT) to every village, to every citizen, to every business and also transform the way Government works [9].

Zhou [12] identifies that in a model of e-government, a

society has three constituents: government, citizens, and businesses. Accordingly, we classify the benefits of e- Sri Lanka pointed out in [5] into three different category; the benefits of e-Sri Lanka are:

For the government:

- Empower civil servants with information and communication tools, to facilitate coordination across government agencies, and to improve competition and transparency in public procurement.
- Integrate marginalized regions and communities within an equitable resource distribution framework, to facilitate effective decentralization and broadening of public participation in development policy formulation and program implementation, and to transform government services cost-effective and citizen-centered.
- To provide quality education at all levels and to all parts of the country. To provide students and teachers throughout the country access to world-class educational curriculum via the Internet.

For businesses:

- To revitalize Sri Lanka's main and traditional industries like agriculture, tourism, and apparel, so that the share of value-addition to the end product is increased, and to penetrate into new markets via Internet-based sales channels.
- To emerge as a major transportation hub for air and sea cargo, by modernizing ports and by developing a modern trade net that dramatically reduced the transaction costs for importers and exporters. To enable businesses to become increasingly competitive and to attract foreign investors.
- To reduce transaction costs to businesses.
- To create a communication environment that allows optimal opportunities for businesses to engage in all forms of e-commerce

For citizens:

- To improve the delivery of public services, and knowledge and education to all, and to make government accessible and accountable to the average citizen
- To create a communication environment that allows optimal opportunities for all Sri Lankan citizens to participate fully in the global information economy, and for all citizens to support their economic, learning and personal needs.
- To facilitate inexpensive contact with family abroad via email and voice over Internet via Cyber Cafes in all towns.

III. Requirement Analysis

This section starts with the results of the needs analysis done

in section-2, and performs the requirement analysis. By the requirement analysis, we are trying to establish a statement about the proposed system that will make all stakeholders agree to it so that the system can be adequately solved [6].

The requirement analysis is done in two steps:

1. Identifying the primitive system: We further dissect the need assessment from section-2 further so that the primitive elements (or the basic building blocks) of the system become visible. This is done in subsection-3.1.

2. Identifying the current status of the system: For this purpose, we measure the e-readiness of Sri Lanka. This is done in subsection-3.2.

From these two steps, we identify corrective measures that can lead to a better solution

III. 1 Dissecting the Proposed Strategy

The implementation strategy for e-Sri Lanka is further dissected in order to find the primitive system; a primitive system consists of the primitive elements or the fundamental building blocks of a system [3]. Dissecting the strategy into programs, subprograms, and actions, is presented in Table-1.

From the analysis given in table-1, we can already recognize some of the primitive elements: government officials and employees, experts and technologists, computer hardware and software resources, entrepreneurs, and general public. To see how the individual programs influence the primitive elements, we check each program and subprogram of the five-program strategy against the primitive elements; the results are summarized in table-2. In table-2, abbreviations HRD, GO, T, GP, IE, BIF, HID, SID, ICTP, SMEs, CCs, BF, EDU, RF, S, and ER stands for human resource management, government officials, technologists, general public, investors and entrepreneurs, building information infrastructure, hard infrastructure development, soft infrastructure development, ICT parks and cyber zones, small to medium-sized enterprises, Internet service providers and telecenters, banking and financial institutions, educational institutions, regulatory framework, Source, and E-readiness, respectively.

Table-2 indicates that the proposed implementation strategy is very influential on human resource development, especially on ICT education. This has two effects, a positive one – the population becomes more IT-literate, and a negative one – surplus computer professionals but lack of inventors and entrepreneurs. A country's capability for innovations and internal improvements cannot be flourished by IT education alone; production technology, supply- and demand chain management, economics, and psychology are all too important in the digital economy era.

III. 2 Measuring the E-readiness

Figure-1 (taken from the authors previous paper [4]) depicts detailed benchmarking of e-readiness of Sri Lanka based on the eight major factors. For comparison, values for Norway are also shown in the figure. In Sri Lanka, demand forces

(capability of the people) are about the average value. However, supply forces and societal infrastructure are poor. In some of the areas (English language usage, tertiary enrollment, high-tech exports, GDP per capita, computers per 1000 people, and telecom costs) Sri Lanka performs poorly.

Some other indicators (political stability = 1.0, and government effectiveness = 1.0) show that there is a serious problem in running the country. In addition, investment in ICT sector is low. After many technology investment debacles, private investors are not so enthusiastic about telecom ventures. The government has also problems in investing in technology sector mainly due to ever increasing health care costs.

III. 3 The Requirements Analysis

The analysis done in subsections 3.1 and 3.2 shows that the policy makers have not given proper consideration to the concept of “domestic digital divide”. For example, from figure-1, it is clear that e-readiness measures gauge disparities that exist between countries (the “international digital divide”). Thus, improving e-readiness of Sri Lanka means improving its stand on the ICT usage compared to the developed countries. However, figure-1 indicates nothing about the domestic digital divide - the gap between citizens of a country in knowledge, access, usage, and mastery of ICT and the Internet. E-readiness improvements may push a country to a better position in competing with the other countries, but it is not clear whether all the citizens of that country will enjoy the benefits due to the improvements. The following examples are on the effects of e-readiness improvement on domestic digital divide:

- Sri Lankan example: Though the government of Sri Lanka believed in reduction of both international and domestic digital divide by its e-government initiatives, however, two official reports recently published prove the opposite results on domestic digital divide, though effects on international digital divide is on Sri Lanka's favor [3][11]. For example, the share of national income of the poorest 10 percent of the population fell from 1.3 percent in 1997 (before the induction of e-Sri Lanka) to 1.1 percent in 2004. For the richest 10 percent, their share rose from 37.2 percent to 39.4 percent over the same period [3].
- Indian example: Referring to e-government implementation processes in India, Sharma and Soliman [8] reports similar unintended negative effects on India's domestic digital divide.

From the above examples, it is clear that e-readiness improvements should benefit all the citizens of a country, especially if it is developing country.

IV. Micro Projects

Figure-2 shows a classification of e-readiness improvement projects. Based on the magnitude of the project or on the size of the projects, the projects are broadly classified as

national level projects and community level projects. Also, depending on the complexity or newness of the adopted technology or mechanisms, the projects are classified as incremental projects, innovative projects, and radical projects. We define micro projects as the community level projects that fall into incremental and innovative types. It is the micro levels projects that mainly uplift the lower masses (“don't-haves”) of a country; thus, the micro projects not only improve e-readiness of a country, it also reduces the domestic digital divide of that country.

Given below are some of the micro projects that could improve e-readiness of a country [10]:

- Community Restoration and Development Projects
- Women's development, rehabilitation, and job training
- Rehabilitation efforts of Irrigation development project
- Skill Development Programme
- School building projects
- Micro Projects on income earning
- Village upliftment projects
- New technology adoption (e.g. solar power, wind mill)
- Grid supplied electric power to everyone

V. Conclusion

This paper proposes a scientific analysis to identify micro projects that can improve e-readiness of Sri Lanka. By this approach, while improving national e-readiness, domestic digital divide that exist between the citizens can also be minimized.

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Program	Subprograms	Actions
A: Building implementation capacity	(A)	Forming control and coordinating committees, to advise the Cabinet of ministers: A top-level consultative committee will be formed, made up of secretaries of key ministries, industry leaders, etc., to advise the cabinet. In addition, an agency will be established to look into the intricacies of capacity building.
B: Building information infrastructure	B1: Hard infrastructure	Building <i>hard</i> infrastructure to provide affordable telecommunications services for various users.
	B2: Soft infrastructure	Building <i>soft</i> infrastructure to support the Sri Lankan software companies, such as stimulation of domestic demand for software applications, establishment of ICT parks and ICT development zones.
	B3: Learning capacity	The government will recruit multinational companies to invest and partner with the local counterparts
C: Development of human resources	C1: Software industry	To increase the supply of ICT professionals, a new policy will be devised on issuing of visas for foreign ICT professionals; Providing incentives for leading ICT multinationals and training institutions to invest in Sri Lanka
	C2: Educational establishments	Training programs on ICT tools in primary and secondary schools for students and teachers; Increased undergraduate intake for ICT courses in universities; Increased training to university staff
	C3: General public	ICT awareness programs for general public; Tertiary education on ICT, and e-learning
D: Delivering citizen services through e-government	D1: G2G	Establishing a government wide-area-network supporting email linking every government institution and employee; Development of fundamental databases of citizen data; Establishing a Sri Lanka Portal for global front-end as administration and service delivery channel
	D2: G2B	Establishing G2B interface that will facilitate interaction between businesses and the government
	D3: G2C	Establishing G2C service delivery infrastructure; establishing a government call center for voice based interactive support to citizens
E: ICT as a key lever for economic & social development	E1: Rural development	Establishing a national fund to support new technology adoption Skill development programmes , Vill job training establishment of telecommunication centers for public access to information and communication services
	E3: Mass media	Sri Lanka's mass media and multi media policy will be revised so that they adhere to internationally established principles

Table-1: Dissecting the proposed strategy

Program/ subprogram	HRD				BIF			Units					S ER
	GO	T	GP	IE	HID	SID	ICTP	SMEs	CCs	BF	EDU	RF	
A	X	X		X									
B	X				X	X	X		X	X	X	X	
B-1					x							x	
B-2	x				x	x	x		x	x		x	
B-3											x		
C		X	X								X		
C-1		x											
C-2											x		
C-3			x										
D	X	X		X	X	X				X		X	
D-1	x	x			x	x				x			
D-2	x	x		x	x	x				x		x	
E			X		X	X			X				
E-1			x		x	x							
E-2					x	x			x				
E-3			x						x				
All programs	X	X	X	X	X	X	X		X	X	X	X	

Table-2: Effect of programs and subprograms on primitive elements and units

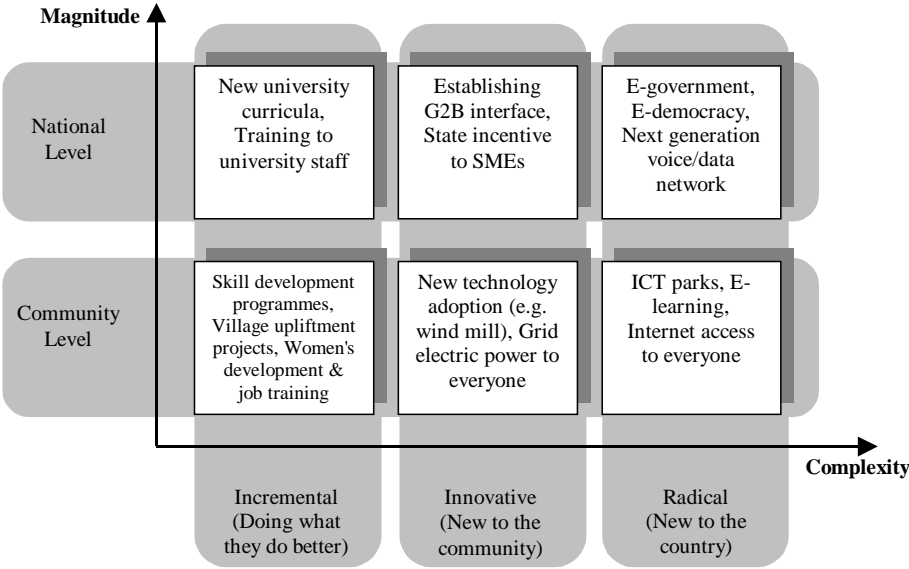
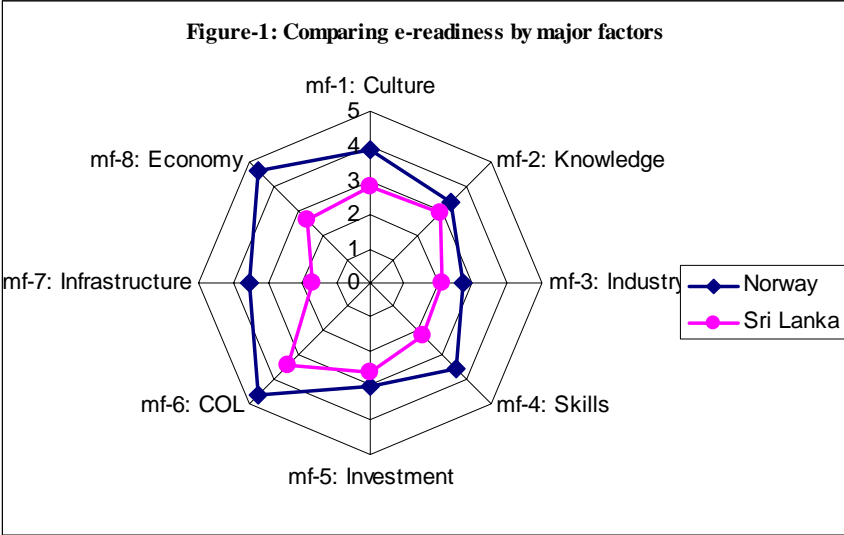


Figure-2: Classification e-readiness improvement projects for Sri Lanka

Online Transactions: Innovative Opportunities and Strategies

Dr. Peder Inge Furseth

Associate Professor,

Norwegian School of Management BI,

Department of Innovation and Economic Organisation www.bi.no

Nydalsveien 37, 0442 Oslo, Norway Phone: (+47)46.41.06.12

Email: peder.i.furseth@bi.no

Abstract: Many companies that have physical channels now also do transactions with consumers online. However, a large part of these companies do not succeed online even if they succeed offline. The literature of explaining and giving advice on such an important challenge is growing, but is still limited. This paper contributes to this field.

In this paper eight strategic opportunities are identified when traditional companies go online. These opportunities are based on personal interviews of general managers who have strategic responsibility for implementing the companies' online channel. While most papers focus on the important role of IT to succeed, the unique findings reported in this paper show that cultural and organizational factors are of higher importance. The paper spells out in detail the content of such factors. In an empirical part at the end of the paper data indicates that the focus on cultural and organizational factors do give higher conversion rates and online sales.

Keywords: E-business Entrepreneurship, E-commerce Management.

I. Introduction

This paper reviews the innovative opportunities available to retailers and banks that sell goods or services online as well as offline. The retailing industry is in a dilemma because companies are afraid of missing an epochal opportunity (Christensen and Tedlow 2000: 42). In this paper the topic is pursued by interviewing experienced managers about the factors they believe to be critical for generating profitability in terms of the online channel. Based on such interviews with managers, this paper presents unique data about managers' perceptions of factors that have a bearing on the integration of online and offline channels. With reference to the same companies that employ the managers, consumers are interviewed about various issues such as online spending and satisfaction with online solutions.ⁱ

There are different views about what the Internet is. Basically, it is a channel for taking orders, for marketing and for searching for information about products and services. That interpretation underpins this paper. Channels other than the Internet can perform the same functions, for example stores, telephones, faxes, mobile solutions, direct marketing, and interactive TV. Unlike the store channel, however, the

Internet channel is available only through a set of technologies.

Some people see the Internet as a technology. The Internet is typically defined as a world-wide network that provides electronic connections between computers, enabling them to communicate with each other using software such as electronic mail, telnet, Gopher, www browsers (e.g. Mosaic or Netscape) and so on. The Internet is in this respect not a single network, but a collection of interconnected networks.

Finally, some people consider the Internet to be a business model for guiding the decisions of companies that are seeking profit. Elliot (2002: 9) presents various types of B2B and B2C business models and classifies them along two dimensions: by degree of innovation and level of functional integration. The e-shop, which bears the greatest resemblance to the kinds of companies in the current study, is classified as having a low degree of innovation and few functions. In my opinion, this categorisation is rather misleading for people who are trying to develop Internet strategies for e-shops. Appropriate strategies for these companies seem to be much more complicated than an overview of business models would lead us to believe.

II. Phases of Business Development

It is the Internet channel as such and not the business done there that is new. However, new strategies need to be developed for the channel. For example, online auctions are not really new. There have always been marketplaces like the stock market and other places where auctions have been held.

This paper departs from the theoretical perspectives that present the various phases of business development with a view to electronic commerce. There is not much available on this topic. In fact, the concept of multi-channel business that figures in the media rather often does not have any accepted definition in the literature.ⁱⁱ

Michael Earl (2000) pointed out that becoming an e-business is an evolutionary journey for most firms. He described the six-stage journey companies are likely to experience. The first two phases are external and internal communication, stage three is e-commerce, and stage four is e-business. The final two phases are called e-enterprise, and transformation. While these steps are stylistic, they present companies in terms of their progress in the work that needs to be done to get a presence online, but they do not give any

hard advice to managers about what challenges they will face or how to handle them.

The benefits of e-commerce arise from the way in which tasks and activities are performed in the retail channel (Burt and Sparks 2003: 284). Burt and Sparks also point out that consumer reactions are not fully understood. In a study of phases of multi-channel retailing, it is therefore important to consider consumers' actions in the light of the way the strategies among companies with transactional websites develop. I will try to move a step in that direction in this paper.

In a recent article, Aldin et al. (2004: 55) pointed to three phases of business development within electronic commerce: Companies initially started with changes on an activity level, followed later by changes in more holistic, business and chain or channel-wide restructuring in an effort to reap the full benefits of electric commerce applications. In the first phase, activities are refined to promote internal efficiency. In the second phase, companies change processes to increase integration and reduce time and costs, enabling service improvements and promoting interplay between the two. In the third phase, companies reshape structures and penetrate new segments and markets. These stepwise refinements are appealing, but they seem too compact in the sense that there are too many factors in each phase, making it impossible for companies to identify appropriate steps in the direction of an online channel. In our opinion, business integration between offline and online channels is a question of degrees. This view is presented in Figure 1.1.

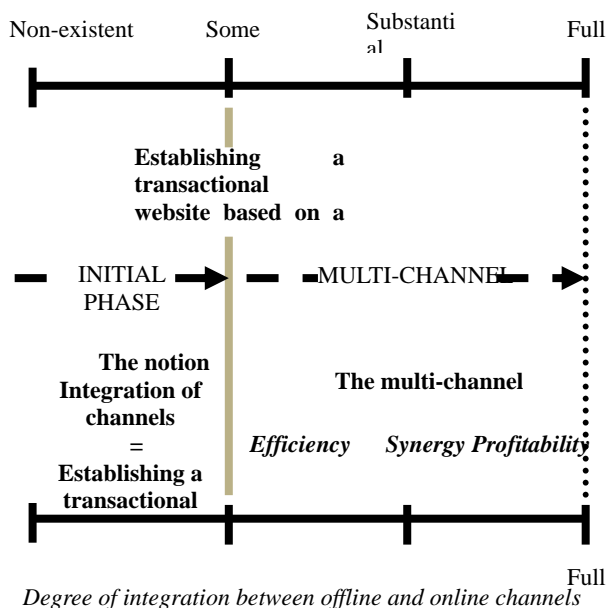


Figure 1.1 The two phases of multi-channel retailing

Some degree of integration should be taken to mean that a company that has a physical outlet also sells goods or services online. This is the degree of integration found in most companies with an online channel, and this is the

degree experienced by the companies in this study. However, although there are stronger degrees of integration, I will not focus on them here.

First of all, companies need to establish a website. Websites are generally used for information, marketing or transactional purposes. Companies then need to align their IT strategy with their company strategy. The companies included in this study have launched transactional websites. Although websites for information and marketing are also important and represent challenges, such challenges cannot be avoided for companies that have transactional websites. Accordingly, this paper will focus on the challenges facing companies with transactional websites.

Once a company has established a channel for selling goods or services online, the multi-channel strategy starts. Multi-channel goals include making the online channel more efficient, developing synergies between offline and online channels, and achieving profitability in all channels. To reach the multi-channel stage, companies need to take advantage of certain innovative opportunities that are addressed in the current paper.

III. Method

Eleven retail chains and banks in Norway were selected for the purpose of interviewing managers as well as consumers. These companies represent a microcosm of the retailing and banking sectors. A total of 11 of the 13 companies in the research project had transactional websites, five of which were traditional retailers: books, electronics, wine, flowers, and sport equipment. There were four banks or banking service companies among the 11 companies as well as one airline and one cruise line with transactional websites. The 13 included just two companies with websites for information purposes.

Personal interviews of the managers in these companies were carried out in October 2003. The insights from the interviews were presented to all the managers at two different meetings, giving them an opportunity to discuss all the insights and to try to arrive at the content of the eight factors. The paper subsequently reports the insights that are common among the managers. These insights were implemented in the managers' own companies, although to somewhat different degrees. Key figures such as online sales and conversion rates were collected from the companies on a monthly basis from December 2002 until October 2004. That facilitated a comparison of online sales and conversion rates before and after the personal interviews were conducted with the managers. Finally, about 300 customers in each of the retail chains and banks were surveyed in June 2004, receiving a response comprising some 3155 questionnaires.

In the event these customers were to buy more about a year after the managers decided on the success factors, I would be inclined to believe that the success factors the managers pointed out may be a relevant source for

explaining an increase in online sales. Please note that there is no causal relationship between the success factors and consumers' actions. However, as managers were interviewed in a number of industries, their insights may have a bearing on other industries in retailing and banking than those named above. For example, one of the companies sells flowers. They are fresh products like milk and bread, so the insights of the flower company represent some of the same challenges facing online grocers.

IV. Why It Is Interesting to Study E-Commerce in Norway

Norwegian consumers are innovative and adopt new technologies faster than consumers in almost any other country. Twenty-five per cent of Norwegian Internet users have ordered a product and/or service online during the past 30 days. This is one of the highest percentages in Europe. Furthermore, Norwegian customers plan to order a lot more on the Internet. Fifty-four per cent of Norwegian Internet users will shop online in the next 12 months. Most customers who shop online spend NOK 1000 to 5000 per month. Customers expect well-known retailers to offer a website with information as a minimum, and a large group of customers even expect retailers to offer a transactional website. Figures from Gallup indicate that 20 per cent of Norwegian customers use the Internet prior to a purchase in a physical store (*Gallup Interbuss* 2003). About 75 per cent of all Norwegian companies have a website and a little over 30 per cent of them have a transactional website (*e-Business Watch* 2004: 38). These are among the highest percentages in Europe, where only Denmark has higher figures than Norway.

V. Eight sources of innovative opportunities

This paper will present eight sources of innovative opportunities, or success factors, that managers indicated were of key importance when establishing a transactional website. Each factor presents a choice that companies need to make.ⁱⁱⁱ There are two ways to increase a company's competitive advantage, that is positioning and operational effectiveness (Porter 2001), and those eight factors are related to this.

The managers suggested eight innovative opportunities. It appears to me that the first four factors seem to be linked to positioning while the others are linked to operational effectiveness. Some factors are specific and concrete while others are intangible. They are listed here in increasing order of reliability and predictability. The first factors are the ones managers know the least about so special consideration is given to them in this paper. This became apparent during our interviews with the managers.

The first four factors refer to positioning, or to doing different things than its competitors do. These are:

- business culture; my or our customers. In many cases people in stores and banks have personal relationships with customers, but Internet channels make these relationships more distant.
- internal organisation; should there be a separate Internet department? If so, how high up in the organisation should the Internet initiative be located?
- assortment; should assortment in the online channel be the same as in the physical channel. If not, should it be wider or narrower?
- price; should a company charge the same price for identical articles sold online and in stores, or should prices differ?

The second set of factors for innovative opportunities refer to operational effectiveness, or to doing better the same things as competitors do. There are four factors here as well:

- logistics; should a company have a central distribution centre or should it ship goods from stores?
- customer history; how best to make use of customer data.
- IT/ERP; should a company use its original system or should it invest in a new system aimed at taking online orders?
- marketing; should customers see the company as one across various channels, or should the company conduct its marketing in different ways in different channels.

For some of these eight factors, the lines will be blurred and there will be considerable overlap. This will become apparent when the factors are presented in more detail later. Each factor has its own characteristics and therefore requires separate analysis.

VI. Four Innovative Opportunities Related to Strategic Positioning

Although each of the eight factors presents new challenges, the interviews with the managers indicate that the following four factors need careful consideration when managers identify Internet strategies. During the interviews, when presenting these insights to the managers, it became apparent that these factors were harder to handle than the other four.

The first innovative opportunity is *business culture*. Companies seek a situation where the employees feel ownership in respect of the Internet channel as well as other channels. Companies also want to get divisions and employees to move away from a situation with my customer and over to our customer. This is typical for retailers and banks. For example, when an item is sold online in an area where the retail chain has a store, the manager of that retail store believes the online sale represents a loss for the store.

Management therefore believes it is crucial to have employees understand the benefit of shopping on the Internet, as the consumer sees it, and to indicate that the Internet channel represents a synergy and does not represent a conflict between channels.

One manager of a retail company said:

I would have used a lot more time on each employee in the stores when we launched the Internet channel. That is very important, because you cannot succeed with transactions online if the storekeepers and other employees don't support the online channel and present it to customers in a favourable way.

A manager in another retail company said:

We tell our employees that customers who shop in more than one of our channels visit us more often, spend a higher amount and are more loyal to our retail chain.

Launching an Internet channel therefore represents cultural challenges to a great degree. Apparently, no matter how well a company solves problems of a technical nature, it cannot succeed with online sales unless their store employees have accepted the channel and support it.

Company management believes customers should perceive the company's contact points as one integrated company. However, in the early phase after the launch of the Internet channel, there are typically various opinions inside each company about whether the Internet channel should be an information channel or be for transactional purposes. Companies have experienced that the level of channel conflicts has become lower, but they also realise it takes time to get acceptance for the Internet as a channel in the companies.

As regards *internal organisation*, companies build their organisation around the Internet channel in various ways, but it seems clear that the Internet division has gained a more distinct role in companies over the past few months. A number of companies will also establish service centres in connection with increased internal focus on online sales. The evaluation underlying these choices is that companies are organising to meet customers' needs as well as possible. The availability of customer service for the consumer is a key issue. Experience with these considerations varies among the companies. A growing number of people in the Internet division allow latitude for conflicts, but the experience of the managers in this dataset indicates that the division has also contributed to positive results.

As far as *assortment* is concerned, the companies have different strategies. One company has 20 per cent of its stock keeping units (SKUs) for sales online (in the sporting goods business), other companies have the same assortment both online and offline, while yet other companies have more items online than offline (books for example). Most companies take account of customers' wishes when choosing their online assortment strategy. At the same time, the assortment online is influenced by costs and internal resources. One manager says that: 'It is neither practical nor feasible to sell all products in all channels'. Another manager points to the fact that some products are easier to

handle through online transactions. This represents a risk, however: 'If you choose to have fewer SKUs online than offline, you at the same time choose to turn a great number of customers away from the Internet-channel'.

The companies say they will continue being market-oriented as regards what part of the assortment will be available online. Customer feedback is considered useful for determining which products should be sold online.

The fourth innovative opportunity that the managers pointed to was *price*. The majority of the companies initially use lower prices online than offline in an attempt to draw customers to the online channel. This is typical for retailers and travel companies as well as banks. One retail manager says that:

To drive traffic to the website, with the increase in rivalry among competitors, it seemed obvious to us we needed to introduce lower prices online.

A representative from a bank says that:

The most important technique to motivate consumers to visit the website is a lower price online than offline. For example, we charge NOK 1 when a consumer pays a bill online, but NOK 20 when he or she pays a bill in the branch office.

Generally speaking, companies that set different prices online and offline do so to attract sales online, and to meet the strong competition from online players. They believe online sales cost less than offline sales.

However, most other companies are convinced that having similar prices online and offline is an important part of their strategy. They fear that consumers may get into the habit of expecting lower product prices online, and that in the long run this would undermine the business model of the company.

The companies that use similar prices in both channels do so partly to boost efficiency and partly owing to a desire not to cannibalise the various channels.

VII. Four Innovative Opportunities Related to Improving Operational Effectiveness

I now turn to the innovative opportunities related to improving operational effectiveness. The first factor here is *logistics*, which is a challenge for retailers in particular. Companies state that the integration of systems and the automation of processes are important. Furthermore, managers believe that customers should be given a larger number of delivery options when ordering online. What lies behind these strategic considerations is the fact that logistics is an area where the companies have identified huge potential economic gains. However, several of them have experienced problems realising these potential gains. Their experience is that establishing real-time in-stock databases and an automated flow of products is perceived as a large and challenging process. However, the managers believe that success in this area entails a huge potential for increasing profits.

When it comes to *customer history* it is apparent that

most of the companies collect information. Banks in particular practise this, since customers give a lot more information to banks than they do to retailers. Most companies have customer database systems and CRM systems. Companies also want to merge databases for traditional stores and online stores. Yet the companies in our sample used this information to a very small degree, if at all. Very few companies have the IT systems required to accomplish this kind of integration since they have old systems, but they realise that such databases are necessary for creating loyalty and sales across channels.

As far as *IT/ERP* is concerned, companies believe these systems should be built with a focus on the new distribution channels and the Internet in particular. Most companies develop systems based on internal resources and competence, while one of 11 companies said that it relies on vendors because it has plans to change its whole IT system. One reason most companies use their own resources to alter their IT systems is that they want to maintain control. The companies realise, however, that their current IT systems often complicate the multi-channel process. The companies realise that upgrading their IT systems is a more time-consuming process than they originally believed.

Finally, as regards *marketing*, many believe that companies need integrated marketing across the various channels. They see a considerable potential for making use of the Internet channel to build company and product knowledge in the market. Most companies want to be perceived as a single brand and a single voice in the market, even if they have channels in addition to the store. The rationale behind this is that companies want consumers to have the possibility to shop through multiple channels. It is believed that customers who shop in more than one channel are more profitable. Most companies report good results from placing strong emphasis on the Internet as a sales channel. This has led to an increased number of visits as well as sales online. Companies have also identified a tendency towards a larger degree of selling across the channels. That being said, efforts to become a multi-channel retailer are clearly perceived as being demanding.

In summary, based on personal interviews and two meetings at which the managers discussed their insights, companies tended to select the following strategies for each of the eight factors presented in Table 1.2.

According to the interviews, companies can be positioned better first by making sure that each employee feels a customer is our customer and not his or her personal customer, regardless of the channel in which a transaction takes place. This is an important element in changing company culture for the better once the Internet is launched as a channel for that particular company. It is also important to link the management of the Internet channel to the company's executive management. Most managers point out that a company should present all its products on the online channel as well, then explain it to customers if all items are not sold online.

Finally, as an important element in doing things

differently from most companies, prices should be similar online and offline. Most of the companies that participated in the study implemented these strategies. At the beginning of the data collection period, in December 2002, some of the companies had lower prices online than offline, but that was not the case at the end of the period. The implementation of this strategy means companies have completed the first phase referred to in Figure 1.2 when it comes to factors that will engender a strategic advantage by positioning them better. In fact, some of the companies penetrated the multi-channel phase slightly, finding that the same prices online and offline increased efficiency.

Table 1.2 Strategy suggestions based on the innovative opportunities

Eight innovative opportunities		Suggested strategies for creating a strategic advantage by positioning the company better
Business culture		Make sure each employee feels a customer is ours and not mine regardless of the channel in which a transaction takes place
Internal organisation		Link the management of the Internet channel to executive management of the company
Assortment		Present all items in the stores in the online channel, and include an explanation if all items are not available online
Price		Similar prices online as well as offline
Logistics		Suggested strategies for creating a strategic advantage by improving operational effectiveness Give customers as many delivery options as possible
Customer history		Have moderate ambitions regarding the integration of customer databases with CRM systems
IT/ERP		Buy a new IT system sooner rather than later
Marketing		Project your company as representing one voice and one brand no matter which channels the customer meets

There was greater consensus among the managers in this project about factors that would create a strategic advantage by improving operational effectiveness. It is important to give the customers as many delivery options as possible to facilitate convenient delivery for them. Most companies should keep their ambitions for integrating customer databases with CRM systems at a moderate level. In fact, most companies realised that they were in great need of a whole new IT/ERP system rather than building more solutions on top of their original systems. Finally, a company should be presented as having one voice and one brand regardless of the channel in which customers meet the company. The managers pointed out that these decisions

belong in the initial phase of the two phases of multi-channel retailing. For companies to be able to develop synergy, which is one of the three goals in the second phase, the marketing strategy entailing one brand and one voice needs to be in place. In fact, some of the companies adopted such a marketing strategy after the interviews had been carried out. Nonetheless, the companies had barely begun to enter the second phase. I can therefore conclude this section by saying that in the current study, these companies are in transition between the first and second phase of the multi-channel process. The opportunities and strategies presented in Table 1.2 indicate what companies need to do to penetrate further into the multi-channel process.

VIII. Consumers' Response

Until now the innovative opportunities available to the managers and what they chose to do in terms of each of them have been presented. The next question is what results were achieved about a year after these innovative opportunities were identified. Did consumers buy more from these companies and did they express a higher level of customer satisfaction, or was there no change? Figures 1.4 and 1.5 present key figures from six of the companies participating in the study; the retailers and the cruise line. These figures refer to online sales and conversion rates from December 2002 through October 2004. They enable us to compare month-by-month trends for the two indicators.

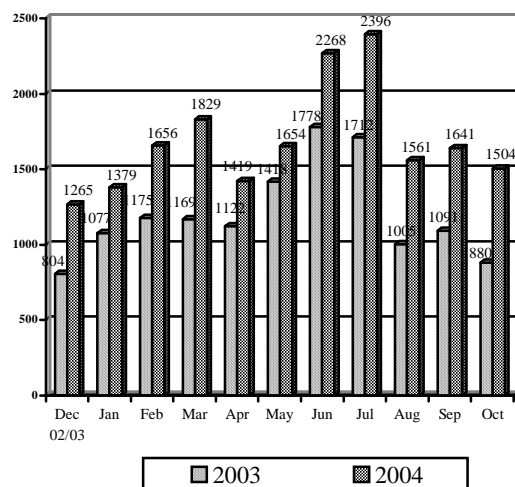


Figure 1.3 The number of online orders among the companies in 2003 compared with 2004

Figure 1.3 indicates that the number of online orders the companies received increased during the period in question. There was an increase in the average figures from 2003 to 2004. Furthermore, there was an increase in the number of online orders from each month in 2003 to the corresponding month in 2004.

The managers were interviewed in October 2003, and

they also shared their insights among themselves at two meetings held right after the interviews. During the period prior to the personal interviews, there was an average of 1203 online orders per month. That figure increased to an average of 1524 online orders per month in the period after the interviews. This represents a 26.7 per cent increase in the number of online orders. The fact that these insights were established does not, however, necessarily explain the increase since there are other variables not accounted for in this study which could influence the number of online orders and conversion rates, for example, the positive e-commerce trend and the fact that consumers are becoming more mature in their use of the Internet.

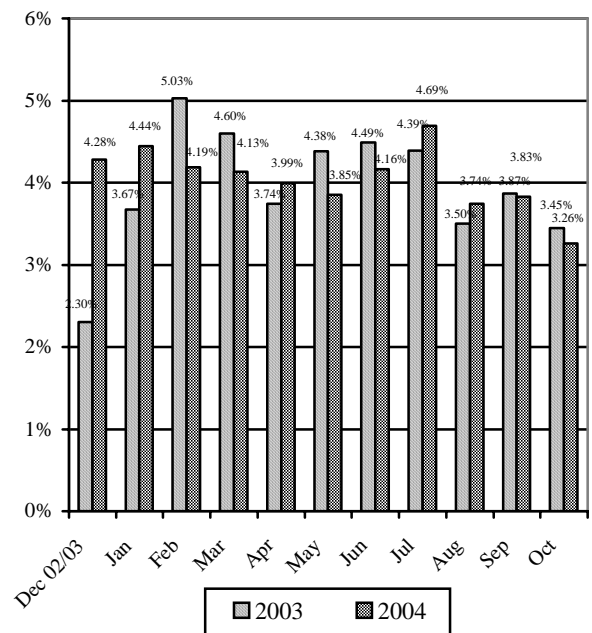


Figure 1.4. Conversion rate among the companies in 2003 compared with 2004

Figure 1.4 presents some results related to the conversion rate, that is, the percentage of website visitors who buy something online. The chart indicates an average conversion rate of 4.5 per cent. In other words, for every 100 people who visit the website, 4.5 people make a purchase there. There was an increase in the conversion rates for half the months in 2003 compared with the corresponding months in 2004, but there was generally little difference from one month in 2003 to the same month in 2004.

Even though the conversion rate remained more or less the same throughout the entire period of data collection, it should be pointed out that the number of unique visits doubled. This means that although the conversion rate remained the same, the number of orders doubled compared with Figure 1.3.

Figures 1.5 and 1.6 refer to a different dataset collected in June 2004. These data were derived from interviews of shoppers or consumers in the companies covered by the

current study. Here the amounts of these consumers' spending online as well as figures that indicate customers' level of satisfaction with the transactional websites of the companies in the current study are presented.

Figure 1.6 compares the amounts customers spent online for retailing and travel with the companies in the current project. The data indicate the amounts of consumers' purchases each time they buy something online. Almost 43 per cent of consumers spend between NOK 200 and 500 each time they buy something from a retailer online, while 23 per cent spend between NOK 500 and 1000 each time. About 20 per cent of consumers spend more than NOK 1000 each time they buy something online from a retailer. Only 3 per cent spend more than NOK 5000.

Consumers spend more online with companies in the travel sector. In fact, 21 per cent of the online customers in the travel sector spend more than NOK 5000. More than 50 per cent of online customers in this sector spend more than NOK 1000. Of the consumers who took part in the survey, on average 33 per cent spent between NOK 1000 and NOK 5000 every time they bought something online.

Products and services typically cost more in the travel sector than in the retail sector. The logistics are often easier for products sold in the travel sector; no matter how much a ticket costs, it can easily be slipped into an envelope, while retailers usually have more logistical problems with the products they sell.

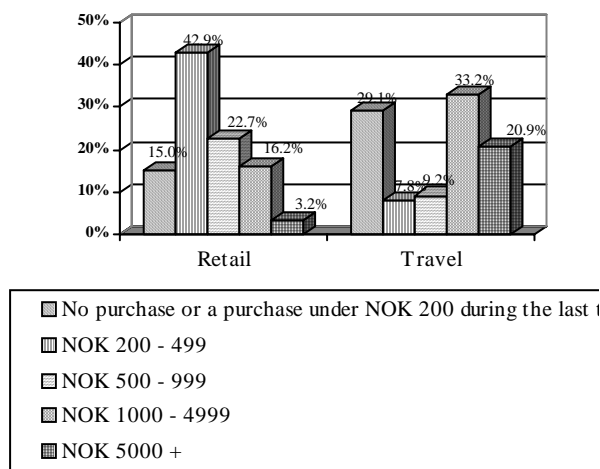


Figure 1.5 Comparison of amounts of consumer purchases for online retailing and travel in Norwegian kroner (NOK). The figures are average amounts each time a consumer buys something online from April through June 2004 (n = 1231)

The next chart examines customer satisfaction when buying online from the companies that took part in this study. The retail, travel, and banking sectors are compared.

Generally speaking, across three sectors consumers are typically either satisfied or very satisfied when they buy something online from the companies participating in the study. As many as 80 per cent of customers in each of these sectors are either satisfied or very satisfied when buying

online.

Customers in the banking sector appear to be the most satisfied when the three sectors are compared. More than 87 per cent are either satisfied or very satisfied when buying online. The banking sector has spent more time and resources in developing multi-channel solutions than the other sectors. It is interesting though to find that consumers are nearly as satisfied with the multi-channel solutions in the retail and travel sectors as with the banking sector.

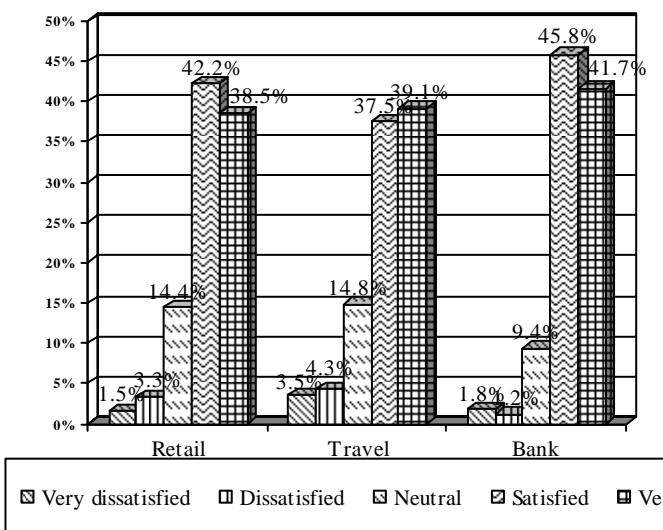


Figure 1.6. Customer satisfaction when buying online: a comparison of three industries (n = 1797)

The numbers presented in the Figures 1.2-1.6 indicate that, generally speaking, the strategies identified by the managers of these 11 companies, as presented in Table 1.2, should not be rejected. Figures 1.5 and 1.6 indicate that consumer spending in these companies is quite high, and that consumers are satisfied with the transactional websites of the companies. It is not possible to determine which of these eight strategies work for increasing orders online and which, if any, do not. Accordingly, they are presented as a set of strategies that should work together.

IX. Conclusion

Table 1.2 presents eight innovative opportunities and strategies companies can follow when establishing transactional websites. The opportunities were collected and identified through personal interviews conducted in October 2003 with 11 managers who were responsible for developing e-commerce in each of their companies. These managers also shared their insights among themselves, arriving at agreement on which factors are most important and how to use each factor when establishing a transactional website. Key figures relating to online orders and conversion rates were collected from these companies over a 10-month period prior to conducting personal interviews with the managers. Such figures were then collected during a 12-

month period subsequent to the personal interviews. In June 2004, about 300 consumers who shopped in each of the companies were interviewed.

The following insights appear to be the most important for helping a company position itself online. Keep the same price online as offline; have a large assortment online; include the Internet department in the executive management of the company and work with company culture so that all employees care about all or most of the companies' customers and not just his or her customers. Online orders increased by an average of 27 per cent during the 12-month period subsequent to the personal interviews, compared with the 10-month period prior to the interviews. When consumers in the participating companies were interviewed almost a year after the managers had presented information about innovative opportunities, they indicated clearly that they were satisfied with the companies' transactional websites.

All in all, the figures for online sales and customer satisfaction turned out to be positive for these companies. This does not, however, present proof that the eight factors listed in Table 1.2 are among those that drive these positive elements, even though the managers themselves tend to believe in these factors. It is hard to establish these eight factors as the cause of the positive developments or even as a cause of these developments. There may be other explanatory factors, such as the positive development in consumers' buying behaviour online and consumers' maturation in terms of online shopping.

However, I would argue that companies should view the eight factors as a set of factors that should be implemented, [9]

if possible, at the *same* time. The results regarding consumer satisfaction online and the number of orders indicate that the managers have been successful in developing e-commerce. At any rate, I would claim that the strategies presented in Table 1.2 should be considered by managers interested in boosting online sales.

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² See for example Coelho and Easingwood (2004: 2).

³ We start out with a broad view of the company, and suggest departing from factors that are either political, economical, social, or technical, as presented in the PEST-analysis. The Internet as a new channel towards consumers influences the company in a wide variety of ways.

Benchmarking the Complementary Features of Online Auction Sites – A Survey

Gautam Gupta
mailto:gautam@gmail.com
Pratap K. J. Mohapatra
pratap@hijli.iitkgp.ernet.in
Mamata Jenamani
mj@iem.iitkgp.ernet.in

Dept of Industrial Engg & Management, IIT Kharagpur, Kharagpur – 721302, WB, INDIA

Abstract: The functionalities required for successful deployment and operation of online auction site can be broadly classified into two categories: *core features* and *complementary features*. Core features are essential for the existence of a site, whereas complementary features enhance a users experience with the site. Since a site has to have the core features, it is the complementary features that contribute to the popularity of the auction sites. We have conducted a survey of 100 auction sites to study 23 features. We found out the similarities among these sites based on their feature vectors. Three distinct groups are formed in the process. The groups are found to be distinct with respect to the core features. We also compared the complementary features of these sites. The results of the chi square tests revealed that the groups do differ with respect to most of these features. We propose a model to assign weights to the features distinctly for three auction site categories. Pareto analyses show important features that contribute to eighty percent of the weights in each group. We next define *Site Evaluation Index* based on these weights. The analysis shows that the sites with higher site evaluation index are indeed the popular ones, as per their ranking in the results of search engines. The highest scored sites can serve as a benchmark to choose the value adding complementary features to guide the upcoming auction sites.

I. Introduction

Increasing participation of end-users in e-commerce has led to enormous popularity of online auctions. Online auctions present many interesting and challenging research issues from studying software architecture and security to understanding the user behavior on the auction Web sites.

In this paper we focus on the functionalities required for successful deployment and operation of online auction sites. Such functionalities for features can be broadly classified into two categories: *core features* and *complementary features*. Core features are essential for the existence of a site. Besides having these features the auction sites also provide many complementary features to enhance users experience with the site. Today, there are hundreds of Web sites dedicated to online auctions. But not all the sites are as popular as that of eBay or uBid. It is interesting to study what features make a site successful. Since a site has to have

the core features, it is likely that the presence or absence of complementary features contributes to the popularity of the auction sites. Our study explores this issue by surveying the complementary features of 100 auction sites.

The rest of the paper is organized as follows. In the next section we present a brief review of the related work. We then describe our survey followed by results and conclusions.

II. Related Work

Online auctions are a blend of technology and tradition, Bapna, *et al.*[2] are of the view that, auctions are as modern as today's technology, yet as old as mankind. Unlike traditional auctions that were limited in scope, online auctions have brought this mechanism to masses. Almost all the traditional auction models have been implemented on the Internet. As identified by Dans [6], 11 different auction models were found to be in use. These include traditional formats like English and Dutch auctions or their variants like Japanese and Yankee auctions. Lucking-Reiley [10] classified auction formats into four major categories: English, Dutch, sealed-bid, and double auctions. He identified various formats in these four categories, for example in sealed-bid auction he found two formats, first price and second price.

The segment benefiting most from online auctions is the business sector. There are three major business models prevalent on the Internet that are used in auction: B2B, B2C and C2C. The most common of these as stated by Dans [6] and Lucking-Reiley [10] also had similar observation. A report by Forrester Research [10] shows that B2B segment underwent "triple digit growth" during 1998 - 2002. According to Parente *et al.* [11] B2B online auctions totaled \$109 billion worth of transactions in 1999 alone and that number was expected to grow to \$2.7 trillion by 2004. This shows the growth and evolution of Internet auctions from plain C2C format to a sophisticated format enabling business to achieve new levels of efficiency. A new trend in business models was identified by Bapna *et al.* [2], as a C2B model for an auction Web sites called *Priceline.com*, which collects information from customers and provides it to companies.

Unlike traditional auctions, online auctions allow users to sell almost any product or service they want. From collectibles to latest brand new products users of online auctions are selling everything. Bapna *et al.* [2] states that

eBay sells goods in over 18,000 categories and sub-categories. Beam and Segev [4] identified that nearly 26% of goods auctioned on the internet are “non-physical” goods, consisting of some kind of software or information. This shows how the Internet has affected the auctions and giving users capacity to put a price on their knowledge also.

Security is a very important factor which must be considered while participating in online auctions. Beam and Segev [4] especially studied security in online auction Web sites and state that only 27% of auction Web sites offered secure transfer of user’s information and only half of these Web sites mentioned security issues on their Web sites and some Web sites offered users to give their credit-card information over fax or telephone. According to Wareham and Cecil [14] auction frauds represent the biggest form of online frauds. Curry [5] identifies more than 13 forms of frauds that take place in auctions online. Bajari and Hortacsu [1] discuss how Web sites can help in reducing online frauds and what measures are currently taken by the Web sites.

eBay is the most popular online auction Web site. According to Beam and Segev [4], eBay accounts for nearly 70% of online auctions in C2C category. Considering the large size of this Web site, studying how eBay operates and how auctions take place on eBay is a topic of interest for many researchers. Since eBay makes its auction data available online for about 30 days after the auction has closed, it makes it easier for researchers to get precise data about user behavior in online auctions. Shah *et al.* [12] study how eBay accepts bids from its users and how users engage in shill bidding and methods to identify shill bidding. Shumeli and Jank [13] developed a tool STAT-zoom to understand how eBay operates.

Wellman and Wurman [15] target the processing of huge amount of information on auction Web sites and how to synchronize the data processing. Kumar and Feldman [9] address the issue of designing a secure and easy to use auction Web site. They have developed a generic software model that can be used in many situations for any auction format. Huhns and Vidal [7] address the issue of agents and advocate the use of standard XML based protocols to allow better use of agents. Wurman [16] discusses the issues related to the temporal and data intensive behavior of the auction system that a developer or an auction service provider must consider. He says that though all the auction system provide same core functionality of bid processing, they differ widely in providing complementary features, which requires a very flexible system.

Dans [6] surveyed over 300 auction Web sites in 1998 to identify the auction and business models used. A similar survey was conducted by Lucking-Reiley [10]. Using 142 Web sites, he studied the economic features like the value of goods sold on a particular Web site, presenting an economist’s view on auctions. He also studied eBay and compared it to new auction Web sites, Yahoo and Amazon. To find the current state and changes in online auctions Beam and Segev [4] surveyed 100 Web sites to identify current practices, new trends and business models in online

auctions. Barnes and Vidgen [3] assessed the quality of four popular Web sites based on its customer’s survey. They developed WebQual a tool for assessing the quality of internet sites.

III. THE SURVEY

The survey covered 100 auction Web sites operating on the Internet and studied 23 core and complementary features of these Web sites. The aim of the survey is to understand the current state of online auctions, studying the features and services provided by the auction Web sites. The survey was done during January and February 2005.

III. 1 Selection of the Sample

The sample was selected using Google (www.google.com), Yahoo (www.yahoo.com), Khoj (www.khoj.com) and Rediff (www.rediff.com) search engines and auction site listings at Rediff and www.internetauctionlist.com. Rediff and Khoj were used for selecting Indian Web sites. Google and Yahoo search engines were used for searching for other Web sites. Internetauctionlist.com lists all the auction Web sites around the world, both traditional and online. Since all the references considered for this work, surveyed almost similar number of Web sites, the sample size selected for this work is considered reasonable. The overall sample demography consists of 11 Indian Web sites, 2 Canadian Web sites, 7 European Web sites, 2 Japanese Web sites and rest are from US. The names of the Web sites have been provided in Appendix B.

While selecting the sample it was found that though there are many auction Web sites that have been included in auction listings and search results, some of these Web sites no longer operate. In some cases as many as 60% of the links were false. When some of the links given by Lucking-Reiley in 1998 [10] were checked they were not working properly. Hence it can be said that most of the Web sites that are not popular, last only for few years. In our survey also 100 Web sites were found fully functional after considering all the possible sources of information. Beams and Segev [4] had a similar result, when they say that nearly 31% of the auction Web sites they surveyed were less than a year old, 27% were less than two years old and the rest 39% were more than three years old.

Online auctioning segment is dominated by some popular Web sites. When selecting the sample it was found that many Web sites use the resources of the popular auction Web sites to conduct auctions for them. For example, www.artstall.com redirects to the arts section of www.baazee.com. Air Sahara uses www.indiatimes.com to conduct its auction for airline tickets. These few popular Web sites have multiple domain names registered with them, for example, two domain names that lead to Baazee.com are www.baazee.com and www.bidorbuyindia.com. So, even though there are many domain names and search results that show up while searching for online auctions, the segment is

actually dominated by few popular Web sites.

Finding 100 auction Web sites proved to be more time consuming than expected because the search results and Web site listings include a lot of Web sites of offline auctioneers. These Web sites do not host any auctions and were simple Web sites for traditional auction houses. So, even though all the auctioning is not done through Internet, traditional auctioneers do realize the power of Internet, and feel the need for online presence. Sotheby's, which is the second largest auction house in the US realized the threat that auction Web sites pose to them and declared that they too will be expanding into the Internet domain. In the survey www.teletrade.com is a Web site which engages in both online as well as offline auctioning.

III. 2 Selection of features

The selected Web sites were studied for various core and complementary features. The survey of the literature helped in identifying four core features and nine complementary features. They are listed in Table 1. EBay, [18] being the most popular site and the choice for many such studies was used as a representative Web site to select one more core feature and nine other complementary features. Thus a total of 23 features were studied. Appendix A gives the list and descriptions of all core and complementary features. Most of the features were checked for their presence and absence only, marked by 1 and 0 respectively. However, features like, business models, auction format, phases of auction, payment methods, scripting language were marked for each category in these features. Text-graphics ratio was approximated for each Web site based on the design of its home page.

Table 1: Feature References

Core features	
1.	Business models: B2B, B2C, C2C [6]
2.	Auction formats: English, Dutch, Buy-it-now, Sealed bid, Reverse [6]
3.	Number of products categories [4]
4.	Payment options [16]
Complementary features	
5.	Faulty user identification [16]
6.	Seller's ranking [16]
7.	Search facility [8][16]
8.	Advertisements [8]
9.	Career oriented services [8]
10.	Auction update notification [16]
11.	Text-graphics ratio [8]
12.	Security [7]
13.	Sitemap [8]

III. 3 Collection of Data

All the Web sites were visited and scanned for relevant data. Particularly Home page, Help and support pages, Site map, and Registration page for both seller and buyer along with few other pages provided most of the information needed. In

most of the cases homepages provided information for the features like, faulty bidder/seller identification, search facility, advertisements, career oriented services, links to other sites, help and support, customer feedback forum, language customization, sitemap, other services, customer counter, book marking, scripting language and text to graphics ratio. Help and support pages provided information for business models followed, auction formats used, payment method available. Site map was used for finding broadly what categories of products were auctioned on the Web site. To get information about newsletter and auction update notification, registration pages for both buyers and sellers were visited. Besides this, a few auction pages were visited to know about shopping basket and phases of auction.

IV. Results

This section is divided into five subsections. We first present observations based on each feature. We then perform a cluster analysis and group the Web sites followed by across group comparison of complementary features. We then present the benchmarks for complementary features.

Feature-wise Observation

Business models: The distribution of the business models were 19%, 62%, and 58% respectively for B2B, B2C and C2C. B2C and C2C dominate the auction segment. There is a very high percentage of overlap between these two categories. In B2C model Web sites that sell their own products and/or allow other businesses to use their site to auction their products are included.

Auction formats: In the survey, 6 popular models (English, Dutch, Yankee, Buy-it-now, Sealed bid and Reverse) were searched for in the Web sites. The distribution of these models is: 90% English, 78 % Dutch, 72% Buy-it-now, 2% Sealed bid, 2% Yankee and 16% Reverse auction. English auction is found to be the most popular format, followed by Dutch and Buy-it-now auctions.

Categories of products: For the purpose of surveying the products were divided into 18 broad categories. Most of the Web sites offered products from multiple categories. However, a few Web sites auctioned items from a single category (e.g. auction.newline.com). The divisions of Web sites according to the number of product categories they offer are: 1 category 33%, 2 to 5 categories 37%, and more than 5 categories 30% of the sample.

Payment methods: The B2C and C2C auction Web sites are just a medium for hosting Web sites. These Web sites do not sell their own items to the users. Hence, these Web sites only facilitate item and money transfer between the bidders and the sellers. For this purpose almost all the B2C and C2C Web sites use Pay Pal service. Web sites give sellers option to select the payment options they are comfortable with. These options include money orders, cheques, bank drafts etc. In this case Web sites do not have any role to play. In case of B2B Web sites and B2C Web sites that sell their own

products, credit cards are the most used form of payment.

Phases of auction: Online auction proceeds through four phases, namely, Registration, Bidding, Payment, and Dispute handling. All the Web sites surveyed follow the above sequence of phases.

Seller's rating and faulty user identification: Auction Web sites collect user feedback based on their interaction with the sellers on their Web sites as a mechanism to prevent frauds. This feature is limited to C2C Web sites primarily and B2C Web sites that allow other businesses to sell on their sites. 79 Web sites are found to offer this feature. When customers deal with a direct seller site such as Onsale or uBid, they do not have to worry about fraud because they are buying directly from the auctioneer.

Shopping basket and search facility: Among the Web sites surveyed 79 sites had shopping basket feature. Almost all the Web sites had search facility.

Advertisements and career oriented services: Revenues for any e-commerce Web sites not only come from the product they are selling but also from advertisements. In the survey, 35 Web sites had advertisements. Only the homepage of the Web sites were used to judge this feature. Most of the Web sites that had this feature were C2C and B2C. The auction sites use their Web sites as a medium to advertise the job openings they may be having. It was found that only 12 Web sites advertised their job postings on their sites. These few Web sites are among the most popular auction sites. These include eBay, Onsale and Baazee.

Links to other sites and other services: Some auction houses have multiple Web sites. For example, eBay has more than one Web site. Apart from one, other eBay Web sites are dedicated to a single product category like auto auctions. In the survey 11 Web sites were identified that had multiple Web sites. 21 Web sites are not dedicated to auctioning alone. They are offering other services like email, news, shopping etc. Some of these Web sites are auctions.yahoo.com and auctions.indiatimes.com.

Newsletter and auction update notification: Almost all the popular Web sites had a newsletter that they circulate among its users. To check the presence of this feature Web site's registration pages were checked. Usually Web sites ask the user's preference to subscribe to a newsletter. Auction update notification means that Web sites inform the users about the updates that have taken place in the auction they are participating. For this purpose Web sites collect user's email address. All the Web sites in the survey notified users about the updates via email.

Help & support and sitemap: Almost all the Web sites had some sort of help pages, but the quality information varied widely between big and small Web sites. This could be one of the reasons why a few Web are more popular than others. Sitemap was found to be present in all the sites.

Feedback forum and book marking: B2C Web sites have a large number of customers across globe. To get feedback from them and to keep users hooked to their sites, they provide discussion forums as an additional feature. Web sites also provide link that allow users to book mark their site

easily for future use. In the survey, 14 Web sites had users' discussion forum. Most of these 14 Web sites were popular Web sites like eBay, Yahoo and indiatimes. The book-marking feature was provided by 16 Web sites.

Language customization: The European Web sites that were surveyed provided this feature. These Web sites could be seen in almost all European languages. None of the other Web sites had this facility. This may be probably because the European languages are very much similar in writing, they use the same script so programs can be easily written that translate one language to other.

Scripting language and text-graphics ratio: This feature was studied to study what scripting languages are used by the auction Web sites. Five different languages were taken and their use in the auction sites was measured. The distribution of sites according to the scripting language is: 46% use ASP, 23% use PHP, and 31% use JSP, CGI and Cold-fusion. Text to graphics ratio was measured to know the level of usage of graphics in the Web sites. It was a general observation that popular Web sites like eBay and Onsale used much more images and graphics in their Web sites as compared to other Web sites.

Security: There are various aspects of security that Web sites must take care of, to protect their users. In this survey Web sites SSL security was studied. Among the Web sites studied 69% had SSL security. All the Web sites that had SSL security were using to encrypt only user sensitive information, but www.ebidderz.com is fully SSL secured. So, even when a user is simply browsing the Web sites he can be sure that he is visiting a secured Web site. In contrast Segev and Beams [4] reported that in 1998, only 27% of auction Web sites had this security feature. This clearly shows an increased concern among the Web sites to safeguard their user's sensitive information.

Grouping the Web sites

To further study and analyze the Web sites features we try classify them based on certain characteristic(s). But it was found that the Web sites were overlapping in many features, hence, it was not possible to divide Web sites into groups by considering differences only in a few features. To solve this problem we performed a cluster analysis of all the 100 Web sites.

All the Web site features except number of product categories, phases of auction, help & support, search facility, scripting language and text-graphics ratio were used in clustering the Web sites. These features were not used because either they were similar in all the Web sites, like phases of auctioning, help & support and search facility, or they were not measured in a 0/1 scale such as number of product categories, scripting language used and text-graphics ratio. Based on cluster analysis, three groups were identified. The distribution of Web sites in three groups is: Group 1 consists of 32 Web sites, Group 2 of 29 Web sites and Group 3 consists of 39 Web sites (Appendix B). Figures 1, 2, and 3 show the distinct characteristics of the groups based on three core features: Business Model, Auction

Model, and Payment Methods respectively. Figure 1 shows that the dominant models of Group 1, 2 and 3 are B2C, B2B and C2C respectively. These sites also support other business models to enhance their functionality. For example, a site in group 3 may adopt a B2B model to operate its supply chain while at the same time may directly interact with the end users by adopting a B2C model. Figure 2 shows the difference between websites based on the number of product categories they auction. For example Figure 2.b shows Group 2 sites, dominant in B2B model offer fewer product categories compared to other two groups. It is natural for single businesses to have limited product offerings compared to the market places with multiple buyers and sellers (B2C and C2C sites). Figure 3 (Key: On Pay: Online payment option, Off Pay: Offline payment option, No Opt: No payment option) shows only some of the B2B sites have nonpayment options. This may be due to the fact that some businesses might be continuing with the traditional mode of payment with their existing business partners. Appendix C shows examples of some interesting sites in each group with unique features.

Across group Comparison of Complementary Features

The previous analysis shows the differences and similarities that exist among the Web on the basis of their core features. We use chi-squared test to study complementary features. The features, scripting language and text-graphics ratio were however excluded, since they are measured differently. Table 2 gives the p values for the chi-square test. We test the Null hypothesis that *the proportion of Web sites having a particular feature is equal in all three groups* against the alternative hypothesis that *at least two of them are not equal*. Asterisk (*) marked cell entries indicate the features in which the three groups differ. The difference in features like services, career and advertisements can be attributed to the different business models that the groups follow. For example, in case of services, group 1 and 2, the groups dominant in B2C and B2B models, have the highest percentages of Web sites offering services other than auction. These services included Web site hosting service as in *www.afternic.com* or email services from *www.indiatimes.com*. Only Web sites that cater to Businesses or are dependent on businesses for their products offer these services. C2C Web sites (group 3) have the least number of Web sites offering other services. Features like seller's ranking, newsletter and users' forum are different because of the customers the Web sites cater to. For example, in case of seller's ranking B2B Web sites in group 2 offers the least number of Web sites having this feature, probably because the users of these Web sites are authenticated before they participate in auctions on these Web sites. B2C Web sites have a large number of users, so to keep the users hooked to their Web sites; they provide features like newsletter and forum. Other feature in which the Web sites differ is the links to other Web sites feature. This is so because of the fact that group 1, which has the

highest number of Web sites having this feature, contains many popular Web sites, like *eBay* and *yahoo*. These popular Web sites have specialized Web sites devoted to a product category or a separate Web site for other country.

Relative Importance of Complementary Features

We define relative importance of the complementary features in each group by associating weights. The weights are defined as follows:

$$w_i = \frac{NOF_i}{OF} \times 100 \quad \text{For } i = 1, 2, \dots, 16$$

where,

w_i is the weight assigned to a feature i ,

NOF_i is the number of occurrences of a feature i in all Web sites of the group, and

OF is the number of occurrences of all features in the group

Table 3 gives the weights for complementary features in the three groups. It also the ranks of these features based on their weights.

Pareto Analysis of Feature Weights

Pareto Analyses, presented in Table 4, identifies the features that add up to 80% of the weight in each group. These features are shown in *italic*. It can be seen that many of the features are common in the three groups. Common features are: help & support, search facility, seller's ranking, shopping basket, auction update, security and sitemap.

Benchmarking the Complementary Features

In order to have a benchmark for complementary features, we first find out the *Site Evaluation Index*, *SEI*, (defined later) of all the Web site. The sites with highest SEI can serve as Benchmarks. Based on this benchmark we evaluate the design characteristics of the 11 Indian auction sites.

Finding the Site Evaluation Index

$$SEI = \sum_{i=0}^{16} w_i \times f_i$$

where w_i is the feature weight in a particular group and f_i is 1 or 0 according to presence/absence of the feature

Based on this index the Figure 4 gives the distribution of sites in the groups. Table 5 gives the maximum, minimum and the average values of the evaluation index.

In many cases sites with high value of SEI are popular sites on the Internet. Though there is no direct proof for this statement, here we cite some resources that support it. EBay the world's most used online auction website, recently completed its 10 years of existence. On this occasion many of the world's leading news-sites wrote articles. BBC has

written an article titled “eBay’s 10-year rise to world fame” [19]. Similarly, Indiatimes, which has a high score among the Indian sites (SEI 86), is the most popular Indian site as per a US-based market research firm, Ranking.com [20]. Superbrands India Ltd. rated Indiatimes as among the 60 business superbrands [21]. Bidz.com which has a high SEI (96), is a leading online auctioneer of jewelry, art and collectibles according to Market Wire, a leading company news distribution company [22]. CQout.com is the UK’s second largest auction site in terms of sales and has a high SEI (92) [23]. Indiamart, India’s leading B2B marketplace was featured on CNBC as analysed by McKinsey & Company, as a successful online business model that survived the dotcom bust during 1999-2001, has an SEI of 86 [23]. Other than news sources search engines also provide certain measure of the web site’s popularity. Today search engines use advanced techniques to analyse the importance of a web site, with reference to the search query. When Google.com is searched for “online auction” or “auction” keywords, the first 10 results that are displayed include eBay, ubid (SEI 94), Yahoo auctions (SEI 84), QXL (SEI 95) and Cqout (SEI 90). All these auction web sites have a very high SEI in our analysis as indicated in the parenthesis. Similar effect has been observed with other leading search services like Yahoo and MSN.

Where do Indian auction sites stand?

Table 6 gives the score of Indian Web sites in all the groups. It can be seen that Indian B2C-C2C sites (*www.bazee.com* and *auctions.indiatimes.com*) present in Group 1 have a very high score compared to B2B sites in other groups, which have scores less than their respective group’s average score. Indian B2C-C2C sites are very feature rich, compared to other Indian Web sites. Only one Indian B2B Web site has a very high score. This Web site offers auctioning surplus inventory (*auction.indiamart.com*).

V. Conclusions

In this work we broadly classify the functionalities of online auction sites as core and complementary features. We conduct a survey to study the existence of these features on a set of 100 online auction sites. We applied a clustering technique to group the sites into three groups which are distinct in most functional and complementary features. We describe a scheme to assign importance weights to the complementary features in the three groups. It is found that the new featured considered by us (Table 1 and Appendix A) like help and support, shopping basket etc. are among the important ones. We propose a model to evaluate web sites based on these feature weights. We provide some anecdotal evidences to show that the sites with very high site evaluation (SEI) are indeed the popular ones. Therefore we conclude that the proposed model can be used as a benchmark to evaluate the functionalities of online auction site.

Appendix A

Auction Web site Features

Core features

1. Business model
 1. **B2B**: they target business customers instead of individual consumers.
 2. **B2C**: These are sites that either offer their products to consumers, or act as intermediary between merchants and consumers.
 3. **C2C**: This is also known as person-to-person. The auction site acts as an intermediary.
2. Auction formats
 1. English: Bidders offer increasing price, aware of previous bids
 2. Dutch (multiple unit auction): More than one similar items being auctioned. Bidders bid for one or more units, usually more than one winner.
 3. Buy-it-now: Seller specifies a minimum price. Any bidder offering to pay that price wins.
 4. Sealed bid: Bidders submit bids unaware of other bids
 5. Yankee: Similar to Dutch, difference is in Dutch winner(s) pay the lowest winning price, but in Yankee, winner(s) pay what they bid for.
 6. Reverse: Demand comes from the buyers, and sellers bid their price.
3. Number of product categories: number of categories in which Web site had divided the product it was auctioning
4. Payment options
 1. Online payment: PayPal, credit card and online money transfer.
 2. Offline payment: cheques, money orders, cash.
 3. No payment option
5. Phases of auction
 1. Register-Bid-Pay-Dispute sequence of events.

Complementary features

6. Faulty user identification: Warning users about faulty users on the web site.
7. Seller’s ranking: Auction Web sites collect users feedback based on their interaction with the sellers on their Web sites. On the basis of this feedback Web sites rate the sellers, so that other bidders can get information about the sellers.
8. Shopping basket: In order to help bidders keep track of their bids Web sites have a feature called shopping basket. Using this feature bidder can track items without even bidding for them.
9. Search facility: facility to search the Web site
10. Advertisements: advertisements of other companies or Web site’s own services.
11. Career oriented services: information on career opportunities and current job openings
12. Links to other sites: links to country sites or sites dedicated to a special product category

13. Help and support: help content for users to make full use of the Web site
14. Newsletter: circulating newsletter among registered users, containing current happenings on the Web site
15. Auction update notification: Notifying users with update about the auctions in which they are participating
16. Customer feedback forum: forum for users' to discuss the Web site
17. Language customization: facility to view Web site in other language
18. Sitemap: categorization of Web site links
19. Other services: services other than auction, being offered by the Web site
20. Book marking: facility allowing users to book mark the Web site for future use
21. Security: use of SSL security by the Web site
22. Scripting language: the language used by the Web site for programming
 1. ASP
 2. PHP
 3. Other (JSP, CGI etc.)
23. Text-graphics ratio: approximate ratio of text-graphics as they appear on Web sites home page

Appendix B

Group 1
www.bazee.com
auction.indiatimes.com
www.ebay.com
auction.yahoo.com
www.onsale.com
www.ubid.com
www.livetoplay.com
www.aquaauuction.com
auctions.amazon.com
www.quicklysell.com
www.backbayauctions.com
www.thefreeauction.com
www.childrenbookmart.com
/auction/auction.asp
www.auction4acause.com
www.cqout.com
www.qxl.com
www.buyselltrades.com
www.u-1.ca
www.eurobid.com
www.jamesjreeves.com
www.justbeads.com
www.qxlsmartbid.com
www.ebid.com
www.teletrade.com

www.interauct.com.sg
www.bidmonkey.com
www.buysellit.com
www.bidway.com
www.canadabids.com
www.auctionarms.com
www.alpaca.com
www.ducks.org/auction

Group2
www.auctionfire.com
www.sportsauction.com
www.winebid.com
www.travelbids.com
www.matexnet.com
www.beatlebid.com
www.everypart.com
www.auctionindia.com
www.machinetools.com/mt
www.assetline.com
www.afternic.com
www.sellxs.com
www.bid4indianart.com
auction.indiamart.com
www.patentauction.com
auctions.samsclub.com
www.playle.com
www.auctionzone.co.uk
www.gsemarket.com
www.indiaelectricmarket.com
www.dovebid.com
www.ecazoo.com/default1.asp
www.bidvantage.com
www.itauctions.co.uk
auction.newline.com
www.japankoionline.com
www.golfclubexchange.com
auctions.fairmarket.com
www.fastparts.com

Group3
www.bidz.com
www.first-auction.com
www.bidnow.com
www.auction.com
www.7bids.com
www.auctionwin.com
www.theknifeauction.com
www.esiliconworld.com

www.itnation.com
www.ubidfast.com
www.biddersnsellers.com
www.onlineauction.com
www.stamphead.com
www.bidnation.com
www.relicauction.com
www.Friday-auction.com
www.teletradeauction.com
www.componentbazaar.com
www.bid4assets.com
www.bidshot.com
www.stampfair.com
www.eggbid.com
www.indiaenterprise.com
/auctionindex.html
www.baymore.com
www.bidera.com
www.erock.net
www.snatchit.com
www.labx.com
www.allcruiseauction.com
www.buyitmall.com
www.creativeauction.com
www.online-equine.com
www.bullnet.co.uk/auctions
www.bestofferauction.com
www.ebidderz.com
www.ticket-auction.net
www.bidville.com
www.melonbones.com
www.bestfares.com

Appendix C

Examples of Web sites

There are thousands of Web sites on the Internet. Hence it is very important for a Web site to have some distinguishing features, which make it stand apart from the crowd, and attract customers. In all the three groups that were formed, such features were observed. Here is a list of Web sites from each group along with the special features they have.

• Group 1

1. <http://www.auctions4acause.com>: auctions for charity, auctioning brand new items
2. <http://www.qxlsmartbid.com>: uses a new auction format, with multiple sealed bids, where highest (or lowest) unique bid wins
3. <http://www.bidway.com>: uses less commonly used Vickery auction format
4. <http://auction.indiatimes.com>: popular Indian auction Web site, many big businesses, like Air

Sahara and Philips, use it to auction their products, like in this case airline tickets and electronic goods

• Group 2

1. <http://www.winebid.com>: allows a seller to offer its products in a “parcel” which may comprise several lots of wine
2. <http://www.patentauction.com>: auctions patents, only Web site found with this product category listed separately
3. <http://www.golfclubexchange.com>: offers users 48 hours inspection period for the products they have won before they pay for it
4. <http://auction.newline.com>: auctions items used by actors in Newline Cinema films

• Group 3

1. <http://www.eggbid.com>: provides a separate page warning users about spam which contains Web site’s name
2. <http://www.bidshot.com>: first m-commerce enabled Web site
3. <http://www.baymore.com>: enables users to organize private auctions, where only bidders submit bids by invitation through the seller
4. <http://www.ebidderz.com>: the whole Web site uses SSL security, thus protecting user’s privacy

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- [20] News article about indiatimes ranking as most visited Indian website: <http://economictimes.indiatimes.com/articleshow/861831.cms>
- [21] News article about indiatimes among 60 superbrands <http://economictimes.indiatimes.com/articleshow/1225415.cms>
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- [23] Cqout.com information page about the position of company in the UK auction market: <http://www.cqout.com/press.asp>
- [24] Indiamart new article about the analysis done by McKinsey and Co. on their business model: <http://www.indiamart.com/press-section/mediasays/cnbctext.html>

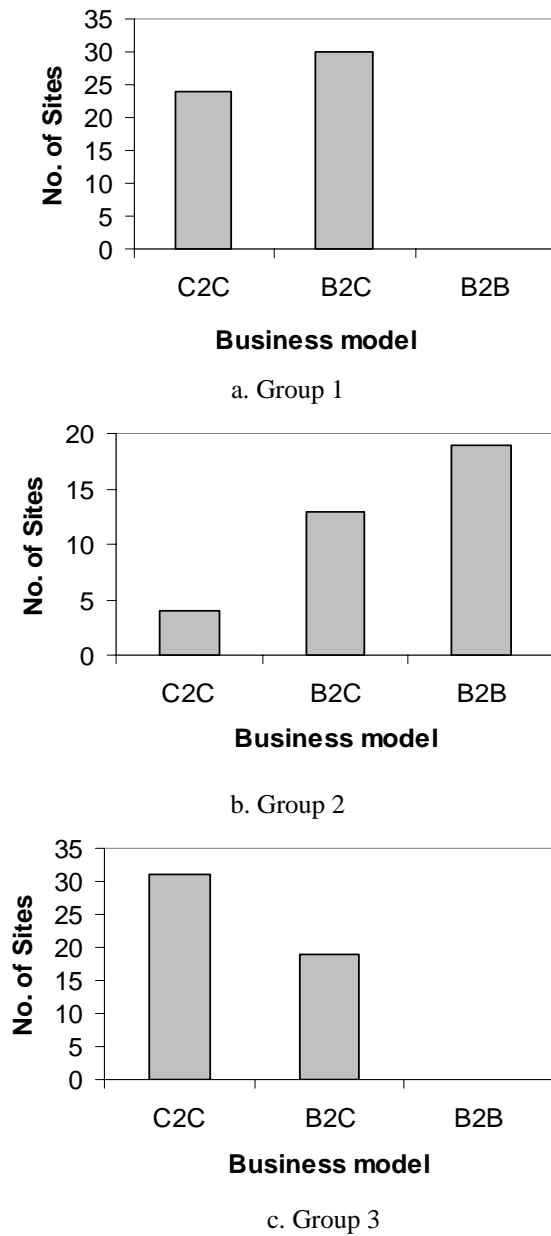


Figure 1. Frequency distribution of “Business Models” in three groups

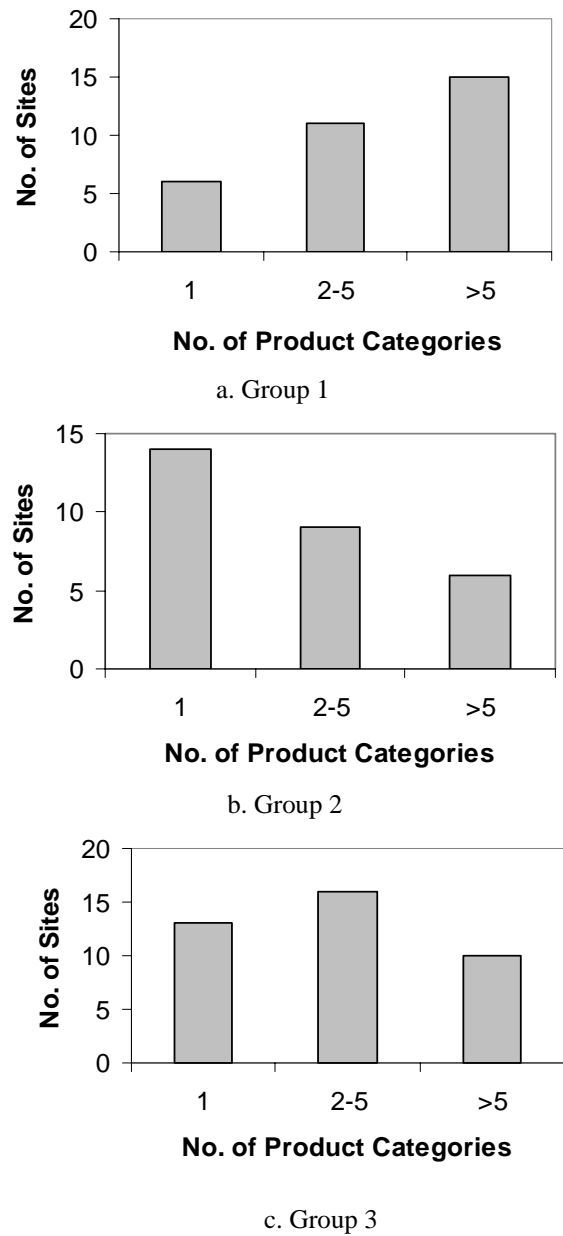
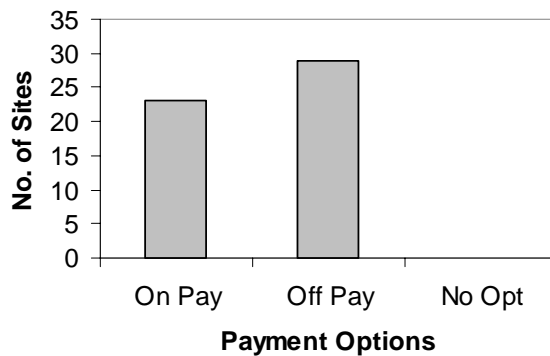


Figure 2. Frequency distribution of “Number of Product Categories” in three groups

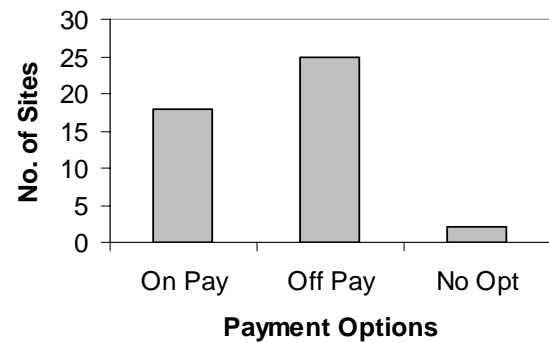
Table 2: Chi Square Test for complementary features

	Group 1	Group 2	Group 3	Chi Sq (p)
	Percentage of Web sites in each group possessing the feature			
Faulty user identification	9.38	3.57	2.56	7.33 E-02
Seller's ranking *	90.63	60.71	84.62	4.15 E-02
Shopping basket	87.50	75.00	84.62	5.94 E-01
Search facility	96.88	92.86	92.31	9.36 E-01
Advertisements *	53.13	39.29	25.64	8.24 E-03
Career *	25.00	10.71	5.13	4.46 E-04
Links *	31.25	3.57	0.00	1.13 E-11
Help & Support	100.00	100.00	100.00	1.00 E+00
Newsletter *	87.50	64.29	51.28	6.92 E-03
Auction update *	90.63	71.43	64.10	8.30 E-02
Forum	37.50	3.57	2.56	1.56 E-12
Language	9.38	3.57	2.56	7.33 E-02
Sitemap	65.63	53.57	56.41	5.07 E-01
Services *	31.25	32.14	7.69	2.99 E-04
Security	75.00	78.57	58.97	2.15 E-01

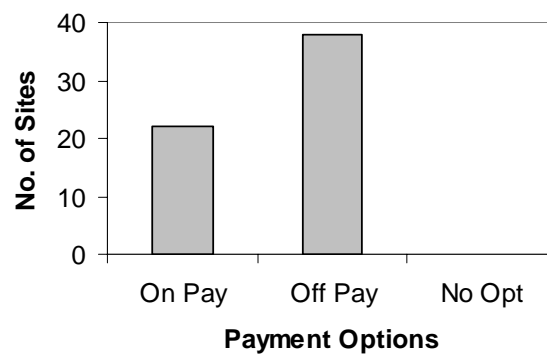
Figure 3. Frequency distribution of "Payment Options" in three groups



a. Group 1



b. Group 2



c. Group 3

Table 3: Complementary features-weights and ranks

Features	Group 1		Group 2		Group 3	
	Weight	Rank	Weight	Rank	Weight	Rank
Faulty user identification	1.03	15	0.97	13	0.40	13
Seller's ranking	9.93	3	8.25	7	13.10	3
Shopping basket	9.59	5	10.68	3	13.10	4
Search	10.62	2	13.11	2	14.29	2
Advertisements	5.82	9	5.83	9	3.97	9
Career	2.74	13	1.94	11	0.79	12
Links	3.42	11	0.49	14	0.00	16
Help &Support	10.96	1	14.08	1	15.48	1
Newsletter	9.59	6	9.22	6	7.94	8
Auction update	9.93	4	9.71	5	9.92	5
Forum	4.11	10	0.49	15	0.40	14
Language	1.03	16	0.49	16	0.40	15
Sitemap	7.19	8	7.77	8	8.73	7
Services	3.42	12	4.37	10	1.19	10
Book marking	2.40	14	1.94	12	1.19	11
Security	8.22	7	10.68	4	9.13	6

Table 4: Complementary features comprising 80% weight

GROUP 1		GROUP 2		GROUP 3	
Feature	Cumulative Weights	Feature	Cumulative Weights	Feature	Cumulative Weights
<i>Help & support</i>	10.96	<i>Help & support</i>	14.08	<i>Help & support</i>	15.48
<i>Search facility</i>	21.58	<i>Search</i>	27.18	<i>Search</i>	29.76
<i>Seller's ranking</i>	31.51	<i>Shopping basket</i>	37.86	<i>Seller's ranking</i>	42.86
<i>Auction update</i>	41.44	<i>Security</i>	48.54	<i>Shopping basket</i>	55.95
<i>Shopping basket</i>	51.03	<i>Auction update</i>	58.25	<i>Auction update</i>	65.87
<i>Newsletter</i>	60.62	<i>Newsletter</i>	67.48	<i>Security</i>	75.00
<i>Security</i>	68.84	<i>Seller's ranking</i>	75.73	<i>Sitemap</i>	83.73
<i>Sitemap</i>	76.03	<i>Sitemap</i>	83.50	<i>Newsletter</i>	91.67
<i>Advertisement</i>	81.85	<i>Advertisement</i>	89.32	<i>Advertisement</i>	95.63
<i>Users' forum</i>	85.96	<i>Other services</i>	93.69	<i>Other services</i>	96.83
<i>Links to other sites</i>	89.38	<i>Career</i>	95.63	<i>Book marking</i>	98.02
<i>Other services</i>	92.81	<i>Book marking</i>	97.57	<i>Career</i>	98.81
<i>Career</i>	95.55	<i>Faulty user identification</i>	98.54	<i>Faulty user identification</i>	99.21
<i>Book marking</i>	97.95	<i>Links</i>	99.03	<i>Forum</i>	99.60
<i>Faulty user identification</i>	98.97	<i>Forum</i>	99.51	<i>Language</i>	100.00
<i>Language customization</i>	100.00	<i>Language</i>	100.00	<i>Links</i>	100.00

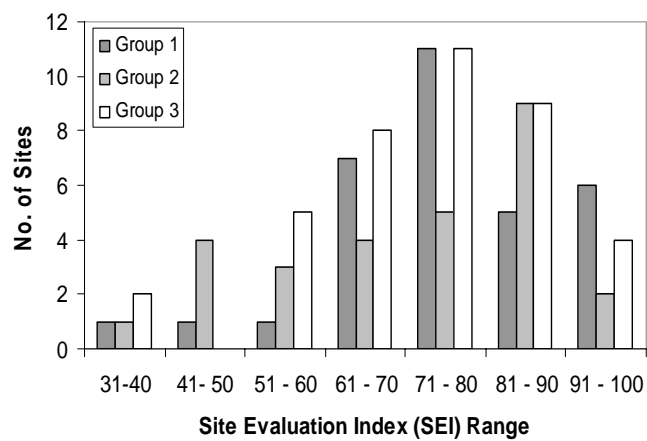


Figure 4: Distribution of SEI in three groups

Table 5: Maximum, Minimum and Average value of SEI in three groups

	Group 1	Group 2	Group 3
Minimum	35.61	24.27	37.30
Maximum	96.57	93.68	96.03
Average	75.08	68.76	72.83

Evidences for relating SEI with the popularity of a site

Table 6: Indian sites' evaluation index values

Group 1	Group 2	Group 3
85.61	44.66	37.30
94.52	50	38.49
	51.45	51.58
	53.88	52.77
	85.92	

The Web Performance of Different Types of Online Insurance Providers – A Wake up Call to Traditional Insurance Providers

Aki Ahonen 1, Richard Windischhofer2

1 Tampere School of Business Administration, aki.ahonen@uta.fi,

Tel: +358 3 215 7617, fax: +358 3 215 7214, Corresponding Author

2 Tampere School of Business Administration, richard.windischhofer@uta.fi

Abstract: The skill of successfully utilizing the Internet as distribution channel for non-life insurance products is examined by comparing the web site usability of three different types of insurance providers from the UK. A long-established, traditional insurance company is benchmarked with a pure online insurer and a groceries retailer that diversified into online insurance. The study is conducted from the consumer's perspective by using expert evaluation techniques and a grounded theory approach. The findings suggest that the newer types of insurance providers outperform the traditional type and therefore represent a significant competitive threat to the insurance industry as we know it today. The theoretical findings suggest that frameworks for analysing web site usability are highly sensitive to context, and in the case of insurance services, *appearance* of the web site and *assistance* to the consumer while using the web site are evaluation criteria that are more important than expected and need to be included when analyzing non-life insurance web sites.

Keywords: E-Business Models and Enterprise E-services Architectures, Usability, Distribution Channels, Internet.

I. Introduction

The Internet is becoming an ever more important channel for business-to-consumer insurance services worldwide. Insurance companies have put their efforts especially to developing electronic insurance services for non-life insurance. Comparing non-life insurance, such as home, car, travel, and legal insurance, to the life insurance business, at least two characteristics are facilitating the development of electronic services within non-life insurance. First, products are less complex which makes the absence of personal contact in service encounters somewhat less critical and second, transaction frequencies are higher. Since business-to-consumer (B2C) customers also perceive the online service channel as essential alternative to offline channels at least in the non-life context [1], insurance companies are eagerly learning how to better utilize the Internet for insurance products and services. Thus, the strategy of insurance companies has been to get B2C customers engaged in the electronic insurance service environment.

Unclear or confusing service offerings might cause customers

to switch providers, especially on the Internet, where consumers can compare prices and conditions rather easily from their desk at home. Therefore, one of the most essential conditions for getting customers committed to a particular insurance provider and to electronic insurance services in general, is to have a B2C interface with good usability and hence, to have a web site that consumers perceive as pleasant to use and to be at.

Along with the rise of the Internet as a service channel, the competitors within the insurance industry have become more versatile. In addition to the electronic service offering from long-existing traditional insurance companies, newer types of service providers have appeared in recent years, for example in the United Kingdom, the United States, and Germany, where groceries retailers, mail-order businesses, and pure online insurance companies have started selling insurance online [20].

These different types of online insurance providers are competing in the same market and often for the same customers. Hence, the question is whether long-established, traditional insurance companies are well-suited to meet the new competition from novel types of insurance providers, or whether the traditional firms have disadvantages, for example due to their previous way of doing business and the resulting set of competencies. We assume that succeeding on the Internet demands a set of competencies which is more likely to be found at the new entrants, such as pure online insurance providers or retailers with previous Internet experience. However, the new competitors might have shortcomings in their skills to provide insurance services and products because of a lack of experience in such business activities. This context of traditional insurance providers competing in a new environment and new insurance providers competing in a more familiar environment provides an interesting research setting and provides opportunities to benchmark the competitor's capabilities with each other.

In order to benchmark these different types of insurance companies, the web performances of three different types of insurance companies from the UK are examined. The UK was chosen as the empirical setting for the present study because of the versatility of different types of insurance providers serving B2C customers. In addition as to the quality of their web sites the UK can be considered overall as the most advanced market for electronic insurance services at this time [20]. Therefore, the UK also provides a useful benchmark for other insurance markets. The categorization of the insurance companies is based on a

previous study [20] about the effect of existing physical distribution channels on online distribution channels in the insurance industry.

The three categories are:

- 1) *Traditional insurance providers* - insurance firms such as Prudential (UK), which have a traditionally strong physical distribution channel but which offer services now online as well.
- 2) *Online insurance providers* - pure online Insurance firms, with the sole purpose to provide their products and services through the Internet, such as Esure (UK). These firms do not use physical distribution channels.
- 3) *Idiosyncratic insurance providers* - providers of online insurance, which have grown out of mail-order firms, or consumer goods retailers, such as Tesco (UK). Tesco recently diversified into financial and insurance services. Firms of type 3 never owned a physical sales channel (at least not for insurance products and services) – but might have experience in selling other products offline and/or online.

The reason for choosing these three particular companies was that each of them represented the best performer in their category [20], and therefore they provide interesting benchmarks for their domestic competitors and international markets as well.

The objective of this study was to evaluate the usability of web sites of the three types of companies in order to a) find out what customers perceive as critical issues for the usability of insurance web sites, and b) whether the newer types of insurance providers (type 2 and 3) have an advantage on the Internet compared to the traditional insurance firms, and what that could mean for the competitiveness of traditional insurance providers.

We therefore assume that a large extent of the firm's skills and abilities to utilize the Internet as novel sales channel is reflected in the usability of its Internet pages. In addition to evaluating the differences in performance levels, the goal also was to assess whether the companies have a new approach to online insurance, and how these companies - and the insurance industry in general - could benefit from that approach.

II. Theoretical Framework

In this chapter the main theoretical elements of the study are discussed. Theoretical framework of the paper is constructed by combining the aspects of distribution channel theory, resource-based strategy, and usability theory.

II.1 Distribution Channels

Distribution channels can be defined as “networks consisting of interdependent actors involved in the process of

making a product or service available for consumption or use” [16, p. 2]. Distribution channels continuously evolve and change in order to serve their markets best [16]. The Internet can be regarded as the most recent innovation that brought change to the distribution strategies for insurance products and services. While earlier, most insurance products and services were offered through physical sales channels such as by agents and brokers, the Internet is a new alternative for insurance firms to offer especially non-life insurance products to consumers.

Therefore, numerous insurance firms have adopted a multi-channel strategy by offering their products and services simultaneously through their existing channels of sales agents or brokers, telephone sales, and the Internet. These multi-channel strategies reflect the general change of consumer's purchasing patterns and reflect in particular a trend of consumer's preference for multi-channel sourcing of products or services [3]. Cespedes and Corey [3, p. 75] point out “Customers may wish to buy a product through different channels at different points in time depending [...] how urgent a particular order is, or whether the purchase is an initial buy, a routine buy, or a modified rebuy”. Travel insurance for example, is often taken out urgently before the start of a journey, and because it is of low product complexity, customers often perceive it as more convenient to purchase it via the Internet.

In addition, the consumer's choice of distribution channel is affected by prior product knowledge and the frequency the product is purchased with. Consumers with prior knowledge about insurance products can be expected to be more likely to purchase insurance through channels that do not offer face-to-face assistance. In order to provide access to Internet-based insurance not just to expert-like consumers but to a wider range of consumers, web sites need to feature high customer friendliness and usability that is compensating for the missing face-to-face contact physical channels are offering.

II.2 A Resource-Based Perspective on Channels

When firms perform business activities, they develop task-specific capabilities [13; 19; 5] and when entering a new set of tasks, a new set of capabilities needs to develop that allows the firm to perform well in the new tasks.

Therefore, engaging in a new type of distribution such as the Internet, demands the company to develop new tasks and task-specific capabilities, such as how to present its products on the web site (content and appearance), to enable customers to find the information easily (navigation), and to provide customers with the right support, in case they need a sales person to talk to (assistance).

Because traditional insurance companies have been conducting their business for many decades through physical sales channels it might be more difficult for them to succeed on the Internet because it demands a set of skills including not just knowing *what content* needs to be displayed on the web site, but also *in what manner* this has to be done. Naturally, this requires a new set of skills and thinking

when entering a sales channel that is fundamentally different compared to previous channels. In addition, the company might find it difficult to decide on its Internet strategy because existing channels might perceive the new channel to have the potential of cannibalizing existing channels, although it can also be perceived as complementing them.

Pure online insurance providers are usually backed by well-established companies due to the complexity of the Insurance business and large amount of capital that is involved. Therefore, the pure online insurance firm does have insurance expertise at its disposal and is not a newcomer to the insurance business *per se*. However, the company usually is a newcomer to the Internet and therefore it needs to develop the set of skills that are required for this particular sales channel. From a strategic perspective, being a pure online insurance provider should enable the firm to focus on its core competence and concentrate on developing the necessary skills.

The third type of companies diversified into the insurance business through opening a new Internet channel in addition to their already existing online channels. Here, the company is a newcomer to the insurance business, and therefore needs to develop the skills to provide that kind of business, often in cooperation with established insurance firms and by hiring staff from the industry. However, the advantage the company has is that it possesses a certain set of skills that enabled it to provide other products and service through the Internet successfully, already. Therefore, the understanding of the Internet as a sales channel might be more sophisticated for such a company, which could lead to a significant competitive advantage if the company gains sufficient understanding of the insurance business as well.

II.3 Usability

The goal of web site usability is to provide what potential users would consider to be a successful experience [6]. According to Hennemann [6, p. 133], “Usability exists when the design of the system matches what the intended end users need and want, i.e. when systems operate in the way users expect them to work”.

A corporate web site with low usability may require users to find alternative methods to contact the company in order to do business, or to even choose a competitor. Therefore, corporate web sites are an important part of an organization’s communication and distribution strategy and web site usability represents a key success factor for companies that offer their products and services to consumers via Internet.

Therefore, especially among IT professionals the usability of information systems and web sites in particular, has become an important issue in recent years but academic literature has not given sufficient attention to the subject, yet [2].

Usability studies that use the consumer’s perspective include aspects such as health, safety, efficiency, and enjoyment [14]. Further studies about usability include learnability, efficiency, memorability, errors, satisfaction

[10], and aesthetics [6]. Van Laan and Julian [17, p. 6] define usability as “the practice of taking human physical and psychological requirements into account when designing programs and documents”. In their opinion, the purpose of usability is to improve products and services and make them more intuitive for the user.

Several authors have developed lists of criteria for assessing the usability of commercial web sites [6; 10; 14] but web site evaluations need to be acknowledged as rather context specific, and therefore, usability criteria often differ based on the nature of products and services that are provided through the web site.

Due to the high complexity of products within insurance industry – even for non-life insurances such as car, home, travel, and legal insurances – the lists of usability criteria from previous studies [6; 10; 14] need to be re-evaluated. To pay attention to the context of insurance products and services, a list of twelve usability criteria can be suggested [20], including the following criteria:

- *Efficiency* - Does the user save time by using the web site?
- *Security* - Is data transfer through this web site secure?
- *Informativeness* - What is the amount and quality of information displayed?
- *Aesthetics* - Does the web site look “likable”?
- *Clearness* - Is the information clearly displayed?
- *Learnability* - Is it easy to learn to use the web site?
- *Memorability* - Can the user find its place quickly after glancing away?
- *Supplementary services* - What additional useful services could the consumer get on this web site?
- *Interactivity* - Can the user communicate with a company representative for example through chat or a 24h telephone help line?
- *Enjoyability* - Is it enjoyable to use this web site?
- *Intuitiveness* - Is the firm able to imagine what its users want?
- *Assistance* - Does the web site offer the user assistance?

While this list of twelve usability criteria has proven helpful for evaluating the usability of online insurance web sites, an alternative, more cumulative model is deployed in this study, proposed by Scharl and Bauer [14], which includes as evaluation criteria *content* (presentation of the information), *navigation* (navigational clues), and *interactivity* (nature of the interaction between the user and the site).

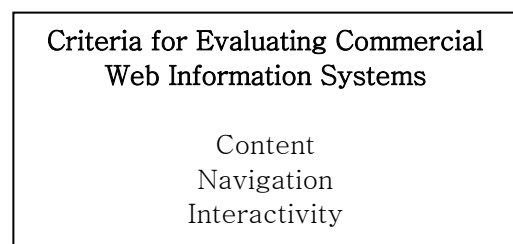


Figure 1 Criteria for evaluating commercial web sites [14]

III. Methodology

The research methods and the execution of the empirical research are discussed separately in order to provide a better insight into the research design and to contribute to the improvement of usability research methods. Here, a novel way of analysing usability is introduced through using a combination of heuristic evaluation [11; 12] and grounded theory approach [4].

III. 1 Research Methods

When it comes to evaluating the usability of web sites, an important distinction between the objective ease of use and the perceived ease of use needs to be made [18]. While the objective usability is determined by the systems' usability features, the perceived usability also depends on the individuals' proficiency with the system. Hence, this study approaches usability from the consumer's perspective.

This study focused on the perceived usability, because although usability research methods are used, our main focus is on service business research within electronic insurance environment. The three selected insurance companies' web sites are evaluated with the help of a group of 28 students. The perceived usability is assessed by following an expert evaluation (i.e. heuristic evaluation) technique [12; 11], meaning, that the students are evaluating the web sites themselves by inspecting user interfaces with a set of guidelines or questions [11]. The key elements of the heuristic evaluation technique are combined with the usability evaluation framework by Scharl and Bauer [15] and adapted to the insurance context.

As to the quality of the results the aim was to get as competent responses as possible but, on the other hand, the responses should also represent the opinions of consumers. Therefore, the participants were chosen from a group of university business students with insurance sciences as their major subject.

For data analysis, the data was transferred to a software program designed to handle qualitative, non-numerical, unstructured data, called NVIVO. With the help of this program, a grounded theory approach [4] was applied to derive usability categories. The grounded theory method allowed us to keep flexible during the analysis and let the relevant usability categories emerge from the data in inductive steps rather than approaching the subject with predetermined assumptions.

III. 2 Research Execution

The empirical data was collected in two phases. The first evaluation round was conducted in November 2004 with nine, and the second in February 2005, with 19 students.

Before the students started the evaluation process they were briefly instructed about the content and process of the empirical study. The phases and tasks were completed one at a time. The progress of the evaluation is depicted in figure 2.

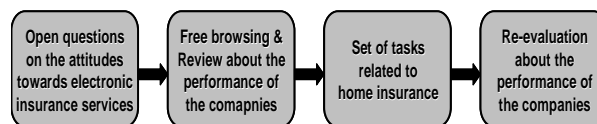


Figure 2 Evaluation process

First, they were asked to shortly answer to six open questions in order to express their opinions on offering electronic insurance services in general.

Second, they had altogether 45 minutes time to get themselves familiar with the web sites of the three insurance companies. After the browsing phase students were instructed to write a one-page review about the three companies and a conclusion where they also indicated how they rank the companies according to their own preference.

Third, after the students had completed writing the review they were given a set of three specific tasks related to home insurance. This phase also meant that they were not just browsing anymore but were challenged to go deeper into the web site and actually try to work with it. Their tasks comprised: 1) finding general information, 2) finding a specific piece of information related to compensation in damage situation, and 3) to retrieve an online quote for a home insurance product. While processing with the tasks the students were evaluating the functionality of the web sites for each of the three companies at a time.

Fourth, the students were asked to reflect on the review and ranking they had written in phase two, and to consider whether their opinions had changed after they had to execute the tasks. In addition, the students were asked to reflect on the six open questions they answered in phase one. In order to investigate how the students perceive the usability and functionality of the web sites, their opinions had to be captured *before* and *after* they had tested the actual functionality.

All 28 students evaluated the performance of all three companies, resulting to altogether 84 evaluations that were included in the empirical data. For all phases, data circulation was used to increase the reliability of the study, meaning, that in order to ensure that every company will be equally evaluated, three different evaluation orders were formed so that every company was evaluated as first, as second and as third by, approximately, 12 students.

IV. Presentation of Findings

In order to emphasize both practical and scientific results of the research this section is divided to present theoretical and practical results separately.

IV. 1 Theoretical Findings

While Scharl and Bauers' [14] categorization is meaningful for a general evaluation of commercial web sites, for online insurance services it needs to be extended by two more categories, namely, aesthetics and assistance.

The reason for extending the existing list of criteria by the appearance criterion is that half of the empirical data that related to the presentation of content was in fact related to aesthetic aspects, such as colour and design. The other half referred to the information or contents itself, meaning, how the company presented product information and the like.

Especially insurance product information - which is often perceived by customers as difficult to comprehend - requires a distinction between the substance that a document contains and the way this substance is displayed.

Assistance is added to the list of criteria because seventy percent of students indicated they would have needed to call the insurance company or enter an online chat at least at one point during the process. About half of these seventy percent would have needed to do so even though they felt they completed the task successfully, for example to make sure they executed the task correctly, chose the right product, or whether the system calculated the correct price.

In figure 3, a list of criteria is proposed for analysing the usability of web sites based on Scharl and Bauer [14] but extended by the two insurance context-specific criteria, namely, appearance and assistance. To a large extent, this list of criteria is a result of the grounded theory method that was chosen in order to let the relevant categories emerge from the data instead of testing pre-defined expectations.

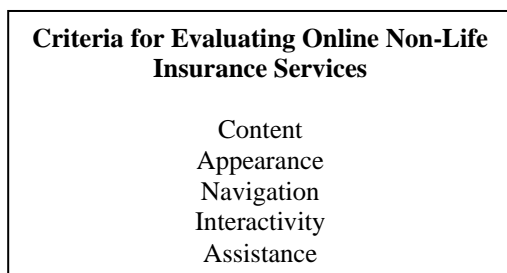


Figure 3 Criteria for Evaluating Online Non-Life Insurance Services

Through proposing a list that includes not only content, navigation, and interactivity, but also appearance and assistance, the requirements of a certain context, namely, the non-life insurance industry are acknowledged because a web site is a platform for presenting a company, which, as part of an industry, shares certain characteristics with firms that are engaged in similar activities. Therefore, the applicability of such a list of criteria is usually limited the context of a particular industry or product group.

The following definitions for the items on the list of criteria are proposed. *Content* refers to the amount and nature of information, including the choice of words. *Appearance* refers to the aesthetic appeal of the web site, its colours, and clarity of design and structure. *Navigation* refers to the ease of navigating, browsing, searching, and accessing information on the web site. Interactivity and assistance are defined in a rather context specific way.

Therefore, *interactivity* refers to the tools that can be used on the web site, such as calculators. *Assistance* refers to the help and advice services that can be used if needed, through telephone and online chat, preferably available 24 hours a day.

IV. 2 Empirical Findings

The opinions of the students are presented in tables 1 and 2 through citing critical episodes, which means reporting those events capturing a problem, misunderstanding, or difficulty in the user's interaction with the web site [2]. For making the comparison between the companies easier the citations are sorted by company. Referring to the theoretical framework, the citations are also divided into five categories: content, appearance, navigation, interactivity, and assistance.

The most essential findings from the phase *before the students had tested the actual functionality* are presented in table 1 and summarized as critical episodes. In this phase the results indicate that Esure was generally perceived as the best company, Prudential was perceived to have a more traditional and trustworthy image of the insurance business, and Tesco was perceived as non-insurance-like and even immature in terms of insurance business.

The most essential findings *after the students had tested the actual functionality* are depicted in table 2. The tasks changed the opinions of the students quite dramatically. The traditional insurance approach (Prudential) was now characterized by complexity and information overload and was outperformed by what was perceived as fresh non-insurance-like approach (Esure and Tesco).

V. Discussion

When comparing the results of the student's pre-task opinions and post-task opinions, a significant change can be observed that is also expressed in the ranking of insurance providers, illustrated in figure 4.

The pillars in figure 4 indicate that Esure maintained a position on the top from the beginning to the end, although it lost some of its appeal after the second evaluation. Tesco was perceived as the least favourable company after the first ranking but in the end it was ranked as the top performer, being even slightly better than Esure.

Looking at the reasons why Tesco improved, students claimed that the amount of information was sufficient and showed a matter-of-fact approach to insurance information that was pleasant to experience because of the joyful web site appearance. The clear site structure and design also enhanced the navigability of the web site, which made it possible to easily search and access the information needed.

Prudential was seen as trustworthy and matter-of-fact, traditional insurance service provider in the beginning. However, those very characteristics typical to traditional insurance business were criticised after the students had to execute the tasks, and Prudential's web site became

perceived as to be “too traditional” or the layout being even “boring”, and that too much information is available which makes the site “complex”.

It also needs to be stressed that many test persons felt indifferent about whether there was not enough information *per se*, or whether it just was not accessible in the right way. Here, the lack of product information or lack in its accessibility can decrease the trust in a web site. Prudential's site structure that was originally praised, was perceived as unclear and confusing after the tasks, and as a result of that, students claimed the site to be very difficult to navigate.

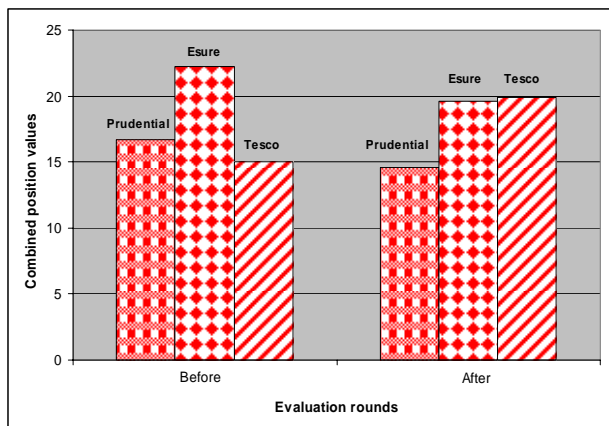


Figure 4 Ranking of firms before and after the task phase

In Esure's case, many students complained that besides the clear site structure and pleasant appearance, the amount of information was insufficient. Here, it was interesting that the small font size made the information hard to read, which created discomfort among most of the test persons. Hence, the fact that information was hard to find or perceived as insufficient largely comes from the company's choice of too small font size on the pages behind the front page.

One of the key issues that need to be addressed for improving the usability of web sites is the content. The content significantly affects the ability to navigate on a web site. Sites with good content but too small font-size for example drop in their usability significantly, even if they have a clear structure, such as Esure had.

Aesthetic elements, such as color and clear design are important issues as well especially when giving a first impression to the consumer. In addition, color and design are key attributes for making content accessible and making a site easy to navigate.

Solid appearance, such as sophisticated looks, structure and colors, is important for the image an insurance company needs to convey, but lack of clearness in design can cause the customer to get lost on the web site, as has happened in Prudential's case. In addition, Prudential's trustworthy image that was conveyed originally, conflicted with the consumer's perceived lack of information and difficulties with getting access to it, making them feel lost and perceive the company as not transparent enough.

Ease of navigation and sufficient information has been the key of Tesco's success. While its image is non-traditional and can be perceived as immature by some consumers, insurance information is matter-of-fact and easy to access, showing that Tesco has skills in presenting the essential features of an insurance product.

From a theoretical perspective, the findings indicate that the task-specific capabilities these three insurance providers developed through their rather different business activities affect their ability to create a user-friendly web site, and provide online insurance successfully. Therefore, a distinction needs to be made between different competitive advantages in the context of online insurances.

Prudential represents a traditional, long-established insurance company, which, through its business activities, has developed a certain set of skills and capabilities that allows the company to serve customers with its comprehensive knowledge about the insurance business. This knowledge, however, leads in the absence of experience with the Internet to a bureaucratic approach to information and content, which especially affects the navigability of the web site.

More traditional insurance firms also have to manage the Internet parallel to their physical channels. Here, the awareness can prevail that the Internet is an opportunity since it can complement other channels, but there could also be a channel conflict because the Internet might also be perceived as to cannibalize, and therefore take away business that would otherwise be made through physical channels. Therefore, conflicts about the distribution and redistribution of resources within the company and among the channels might reduce the necessary attention from the online channel that it needs to outperform other competitors, for whom it is more natural to have electronic sales channels, such as Esure and Tesco.

Esure can be assumed to have the best preconditions for a successful online insurance business from a usability perspective, because its sole focus on insurance business and the Internet as distribution channel allows the company to concentrate its resources and build up core competencies. The opportunity to start fresh and build an insurance web site where insurance information is displayed in a customer-friendly way, as well as with a fresh appearance and good understanding of the importance of clear web design, certainly gives the company an advantage over its more traditional competitor, Prudential. However, the resources of Esure as a niche player are more limited and its larger competitors do have advantages in economies of scale and scope.

Tesco certainly represented a surprise after it was able to slightly outperform Esure and clearly outperform Prudential not only in appearance and navigability, but also in content, assistance, and interactivity. Tesco, with its successful online business for groceries and non-food retail goods has diversified into financial services successfully, through using its widely recognized brand and its experience with electronic channels. Therefore, it provides a good example

for a company which is not only able to transfer and utilize its capabilities related to online channels from one product category to the other, but it also demonstrated that it is able to acquire new, industry-specific knowledge for distributing insurance products and services.

VI. Conclusion

The key characteristics of insurance business, such as the complexity and abstract nature of products set significant challenges to the development of electronic insurance services. Thus, such usability issues as appearance, clearness, appropriate amount of information, and assistance should be considered even more than in some other service fields.

To summarize the results of our study, some general tendencies related to the web site usability of insurance companies need to be brought up.

First, insurance as a business is based on transferring information and a feeling of security to customers. Thus, it is important to provide an amount of information to the customer that is both – comprehensive and comprehensible. Therefore, providing all information possible cannot be the answer because it easily leads, especially in the insurance business, to information-overload because of the complex nature of the product and the terminology that is involved. Regarding web site usability, providing too much information also makes it difficult to create clear content and design on the web site which significantly affects navigability and, too much information can make customers feel confused and overwhelmed.

Second, lively and non-insurance like layout especially at Tesco's pages was perceived as a rather positive approach to insurance business. Insurance as a business should also create trust between the insurance company and the customer and therefore, a matter-of-fact approach on the web sites has, at least so far, remained widely applied within the insurance field. This study suggests that in addition to the traditional insurance-like approach, there are also other approaches to successful delivery of electronic insurance services, as demonstrated by Tesco. However, service providers should recognize the thin line between a very upbeat or lively look that might give an immature impression and a "refreshing but still matter-of-fact" approach in developing the future electronic insurance services.

Third, small things matter. In environments with relatively large amounts of information necessary and available, clear, visible paths that enhance the access to information are crucial. However, through small details in web site design, consumers can easily get confused or lost, or might not be able to retrieve the information they need, at all. For example, in case of Esure some test persons that originally ranked Esure as best company became confused during the task phase when new information always opened in separate windows, which lead to a more negative evaluation for the company. In this case, Esure, the company

with originally the clearest design still managed to confuse its users through a detail, which could have been avoided.

The change in opinions after the students had in fact used the electronic services was one of the most interesting findings of our study, and one of the key themes of this paper. The user's perceptions from browsing the web site or actually performing tasks show a clear difference between superficial ease-of-use and real usability.

Finally, as already pointed out the results clearly indicate that insurance business does not necessarily have to be characterized by complexity and conservativeness. Insurance service can also be offered by following a different kind of logic based on simplicity and easy-to-use as, especially, Tesco, with its roots in the retailing business has proven.

Traditional insurance companies can learn their lessons from non-traditional insurance providers, such as Tesco, and these new competitors have the potential to become a threat to the traditional insurance business. In the light of previous research [20] and this study, we propose developing the electronic insurance service concept by benchmarking the traditional insurance companies with the non-traditional ones. This might also foster the insurance industry's understanding of how to make customers more committed to using electronic insurance services.

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Table 1 Critical episodes and evaluation parameters after the browsing phase but before the task execution phase

Company	Criteria	Critical Episodes
Prudential	Content	the site was extensive, a lot of information and functions
	Appearance	matter-of-fact and conservative looking layout, trustworthy, caring
	Navigation	clear, moving around is logical and it is easy to go back to the previous screen
	Interactivity	good calculators on the pages; the "quick search" is good
	Assistance	the contact information is displayed well
Esure	Content	there is right amount of text so that you feel you can read it through
	Appearance	it didn't feel at all like insurance business, the pictures were funny
	Navigation	start page is very clear and you surely find the information you want to find
	Interactivity	the calculators and other tools are well-defined and comprehensible
	Assistance	there is advice available if needed
Tesco	Content	the product supply of Tesco is fairly good
	Appearance	the animated pictures decrease the credibility and trustworthiness
	Navigation	the pages are easy to use and I didn't get lost once
	Interactivity	there is no sitemap or quick search on the start page
	Assistance	if you have any questions, there is advice available

Table 2 Critical episodes and evaluation parameters after the task execution phase

Company	Criteria	Critical Episodes
Prudential	Content	pages are rather unclear because there is an incredible amount of different information
	Appearance	matter-of-fact and conservative looking layout, maybe a bit boring
	Navigation	menus were not clear and visible enough, which makes it hard to move on the pages
	Interactivity	the calculator could work just as well without your personal contact information
	Assistance	the questions which begin the product section are quite horrifying but help is available
Esure	Content	easy to open the headlines but from there on the information was scarce
	Appearance	it opened my eyes that insurance doesn't have to be stiff to make a good impression
	Navigation	I can only move back and forth in filling out information but not get to general menus
	Interactivity	the suitcases on the upper bar let you how close to the end you are
	Assistance	I would call to make sure, because my case is maybe a special case
Tesco	Content	there is sufficient information on the products
	Appearance	modern, up-to-date, new and fresh; important how to present things visually on the net
	Navigation	easy to move on the pages and I didn't get lost, the "quick search" is very practical
	Interactivity	they make it easier for the customer to reach a decision by offering calculators
	Assistance	I would call to make sure the sales representative calculates the same price as I did

Using GIS and CRM to Develop Intermediary Portal E-Business Model: The Case of Automobile Industry

Lihua Zhao
School of Marketing
The university of New South Wales
Sydney, Australia
Email: Lihua_zhao@unsw.edu.au

Abstract: As Internet-based and other virtual technologies are being used more and more for procurement, supply chain management, product development, customer relations, and other business functions, and as they are proving to be efficacious, e-business has undoubtedly become an integral element in the business and engineering strategies of many automakers and suppliers. What e-business can provide to an automotive cooperation has been well stated for improving product quality, reducing costs, and shortening time-to-market cycles.

In this paper, Renault Australia is used as an example of where the automobile industry is currently positioned in relation to E-Business. Online WebGIS-based Marketing Support System, developed as a portal e-business model, is designed to assistant information and knowledge exchange between the market analysis business and decision makers (and sales people) in auto industry. Incorporating marketing information gives rise to a better understanding of the potential of particular market areas or target markets, and helps identify the strengths and weaknesses of the competition in particular market areas or among particular target market segments. Such market analysis strategies obviously provide competitive advantages. Sharing information and obtaining market analysis outcomes through the Web will provide business decision makers with up to date information and knowledge. This solution will not only reduce costs for business planning, but also help to avoid the cost of wrong decisions.

Keywords: E-Business models, GIS, CRM.

I. Introduction

In the automotive industry, retail dealers are independently owned and have a quasi-franchise agreement with vehicle local manufactures or distributors for imported cars. This structure has been in place in most western countries since the 1920s. However, increasing competition and wide adoption of e-business technologies have, recently, challenged the traditional automobile retailing and marketing. Most automobile firms have conducted the transformation to e-business using Web technology.

What e-business can provide to an automotive cooperation has been well stated for improving product

quality, reducing costs, and shortening time-to-market cycles [5]. As Internet-based and other virtual technologies are being used more and more for procurement, supply chain management, product development, customer relations, and other business functions, and as they are proving to be efficacious, e-business has undoubtedly become an integral element in the business and engineering strategies of many automakers and suppliers. Although the automotive industry has comparatively slower e-business progress than other industries, both survey and research have suggested that e-business is becoming and will become more critical in the near future for many automotive companies [5], [10].

In order to meet these challenges most automobile firms have created an integrated and cross-functional e-Business structure, comprising Internet-related activities in the four e-Business domains (B2C, B2B, B2E and e-vehicle). Currently, most automobile firms, such as Renault, Ford and Toyota, have their well designed web sites which provide a good interface with potential customers and aim mainly at marketing their products, reducing operational cost, and managing value chain. However, few opportunities have been provided to potential customers to order vehicles on line. This direct linkage with customers is rarely available at present, however, it will be an essential feature of e-Business for the automobile industry in the next few years. Aligned with this e-business opportunity, managing customer relationship and gaining market intelligent information can be valuable business opportunities as well. These opportunities could be enhanced by using GIS and CRM technologies and implementing atomic e-business models.

In this paper, Renault's e-business suite is analyzed, using atomic e-business models proposed by Weill & Vitale [11], to highlight the current e-business value to Renault and additional e-opportunities.

II. The Current E-Business Strategies and Suites in Automobile Industry

Different automobile corporations have their own different e-business development strategy; however, in essence, they have similar e-business offerings at current stage. The following cases of Renault and Ford demonstrate these similarities.

In February 2000, Renault announced the launch of its E-business Program and the expansion of its electronic-commerce activities [7], [8]. The goal of the e-business program is to develop a comprehensive Renault e-commerce

offering. The program focuses on four areas:

- business-to-consumer;
- business-to-business;
- e-vehicles (production of “communicating” vehicles);
- business-to-employee

“From the start Renault was looking to transform its business processes, both internally towards the company’s employees, and externally towards dealers and consumers on the one hand, and suppliers on the other” [2]. Currently, e-business development is playing a key role in Renault’s B2B business activities, and the B2E area as well. For the area of B2C, “this site (main website) enables end customers to browse the range of models, ask questions, and even configure their own individualized car. From there, they can contact a dealer directly either online or by email.” Although this system cannot provide a real online transaction, the dealers have the prospect of receiving valuable and highly qualified leads. “Not only did this promote contacts between end-customers and dealers, it also shortened the sales cycle for dealers, thus freeing up resources for additional sales,” explains Thierry Moreau, Director B2C. Renault is constantly looking for new opportunities. Some offer immediate promise of success such as the transformation of B2E, the introduction of supplier services, and the improvements to existing B2C projects. Some have a more long-term perspective such as the e-vehicle project comprising online services in the vehicles [8].

Meanwhile, Ford, since the fall of 1999, has been working on an e-business strategy that will link the dealer and the customer as well as the engineering and manufacturing functions to allow a vehicle to be custom-built through the Internet, the so called “order-to-delivery”, which is similar to the Dell model. Ford’s e-business vice president, described Ford’s plan to rebuild itself as a move to “consumercentric” from “dealercentric,” and stated that Ford would transform itself from being a “manufacturer to dealers” into a “marketer to consumers.” But the move is slow, Forrester Research [4], based in Cambridge, Mass., estimates that only about 1 percent of B2C trade were conducted through online marketplaces in 2000. There were many obstacles in Ford’s path. Eventually, Ford has shifted its focus to the B2B model, while keeping the vision on B2C implementation [3], [5].

Based on the e-business development strategies, e-business technology has supported each automobile firm’s e-business suite with easy to use interface, well organized front page as single point of contact for e-business customers to conduct activities related to their purchase and service process such as, products display, online enquiry and newsletters for managing customer relationship, etc. The value of these e-business suites offered can be analyzed using Atomic e-business model framework proposed by Weill & Vitale [11].

For example, Renault’s front web page

(www.renault.com) contains web links to the web sites of Renault in different countries (such as www.renault.com.au, www.renault.co.uk), and links for different services, for example rental of Renault cars in Europe (www.renaulteurodrive.com.au). In this front page model, communication with customers quickly moves to the business unit in different region or different business type. Creating this umbrella web page as a front page has coined the front page whole-of-enterprise model suggested by Weill & Vitale. Renault presents an array of products, services, and solutions to all important parts related to one’s Automobile purchase life (e.g., products category information, test-drive, finding a nearby location to purchase and/or have services). This integrated implementation has a consolidated customer interface. The customer is then able to navigate wide-range offerings to find suitable products and services. All these suggest the integrated whole-of-enterprise atomic business model has been implemented. The value proposition of the models is to increase customer intimacy and service level, and consolidate the brand recognition. The revenue could be generated from the repeated purchases of loyal customer, or out-of-mouth recommendation to new customers, although there is no tangible and quantitative revenue generated directly from using the web sites.

Renault’s B2B e-business strategy is the same as the concept of Value Chain [9] – the set of activities through which a product or service is created and delivered to customers. Renault operates simultaneously both in the physical and virtual worlds. In the physical world, Renault products and services move along the physical value chain from Renault manufacturers/distributor to dealers to customers. In the parallel virtual world information about members (dealers and suppliers) of the physical value chain is gathered, synthesized, and distributed along the virtual value chain. Based on the *Value net integrator model* displayed in Weill & Vitale [11], Renault, as a value net integrator, receives and sends information to all other players (dealers and suppliers), manages relationships with customers and all major dealers and suppliers via using its trusted brand recognized at all places in the value chain. The Net integrator model adds value by means of bidirectional communication, ease connectivity – all at making business activities more cost effective and electronic data interchange. For example, Renault might use information about consumer to increase profit margin by meeting customer need; by using information about suppliers, Renault can reduce cost by cutting inventories. The value proposition provides to increase brand awareness and improve relations with all dealers and suppliers in the value chain. Furthermore, the virtual electronic procurement lowers telecommunication costs, enables effective reduction of administrative cost.

Each automobile firm uses a content management solution (Content Provider) to support the management, distribution and delivery of its branded vehicle products content, that is distributed through its distributors and

dealers in different nations and regions, including the products catalogues and marketing brochures via electronic and physical distribution. The revenue could be the benefit to dealers by directly reducing cost of content production and distribution, alternatively, by providing all professional information to relevant Renault products without direct benefit, the company can avoid at least some portion of the expenses for marketing its products.

Applying Virtual Community model to host virtual space would help to find and retain members who share common interest regarding branded products and services. The activity in virtual community can be in multiple formats, for example, chatting room for customers to ask questions, FAQ for searching answers to common questions, e-learning and e-training regarding the products and offering, newsletters sent via email list, etc. This e-business model can increase the company competencies by discovering customer needs and understanding the value of customers; building an intimacy sense of community, and building loyalty to the community by providing attractive content. Renault could not generate profit from the virtual community directly, but consider it as a cost of brand building and loyalty maintenance.

In summary, using Weill & Vitale's framework, the most commonly used atomic e-business models in Automobile industry are Content Provider, Value Net Generator, Virtual Community, and Whole of Enterprise/Government, however, still more e-business opportunities could be further developed and incorporated into their business models by using Direct to Customer and Intermediary portals models.

III. Additional E-business Opportunities in Automobile Industry

III.1 Direct-to-Customer

At present, most automobile firms do not sell vehicles online directly to the end customers. Implementing online sales provide business opportunity for Renault to realize its "New Distribution" project, which aims at made-to-order production chain. These represent a dramatic change in the automotive industry. Building Made-to-order, instead of for dealers' showroom, Turban *et al* [10] estimated that tens of billions of dollars annually could be saved just from inventory reduction. Online sale has been predicted to be one of the main sale channels after 2007 [5], [10].

Adopting the direct-to-customer model, automobile firms will gain leverage from three sources – relationship, data, and transaction – relative to their current place-based business. Owning the customer relationship, will provide Renault powerful position and influence where the customer looks to the relationship holder for trust and brand reinforcement. Owning customer data will provide the potential to develop powerful insight into its customers' needs and desires, therefore help products development and increase competitive competencies. Owning the transactions

will provide the company more profitable revenue not only in sales of new products, but also with service revenue.

The main sources of revenue will be attained by gaining higher margins of products sales compared by means of cutting steps out of the distribution dealers and reducing the commission to the dealerships. More importantly, having relationship, data and transaction could improve Customer Relationship Management (CRM), the indirect value can be generated from identifying opportunities for increased sales or product offerings, therefore enhance the competitive capability by improving their intelligent, branded e-market analysis.

III.2 Using GIS and CRM to Develop Intermediary Portal E-business Model

Portal, under the general definition of "access point for aggregated information", is continuing to expand, and will be a feature of e-business for some time [11]. The ability to customize a portal allow users to modify the content and format of the information provide by their portal. Applying Portal (Intermediary) atomic e-business model, automobile incorporations can take advantage of rich information, collect, maintain, and share market intelligence with business partners. For example, in the case proposed in this paper, market analysis displayed on maps in appendices can be provided by a e-business portal which is supported by a WebGIS-based Marketing Support Systems. Such e-business portal is designed to assist information and knowledge exchange between the market analysis business and decision makers (and sales people) in auto industry.

A WebGIS-based Marketing Support System uses Geographical Information System (GIS) technology as the backbone. GIS is a digital mapping and spatial analysis system capable of assembling, storing, manipulating and displaying geographically referenced information. The power of a GIS in business decision support areas is its ability to manage spatial data from a number of sources, to display spatial data, and provide spatial analysis modelling [1]. A Web GIS platform provides a powerful online data process and display system. However, much of its usage for online e-commerce has been to explore initial ways of querying and acquiring geo-referenced data or images (e.g., online maps for tourists). Our innovation is to integrate CRM (Customer Relationship Management) techniques into a Web GIS platform, providing dynamic database management and market analysis.

There are three distinct advantages in adopting GIS and CRM technologies in market research. First is the ability to overcome the weakness embedded within each system by integrating GIS capabilities with the power of CRM. Second is the ability to use effectively data from different sources for market analysis, such as Census. Third is the advantage for users of being able to visualise spatial data in different forms; for example, to visualise the spatial distribution of data on maps prior to further market analysis. In this way the application of GIS and CRM in market analysis can be seen as decision support tools for reaching a desired solution, and

therefore could be used widely for solving practical marketing problems related to retail chain network planning based on demographic analysis, marketing positioning, and consumer targeting.

Incorporating marketing information gives rise to a better understanding of the potential of particular market areas or target markets, and helps identify the strengths and weaknesses of the competition in particular market areas or among particular target market segments. Such market analysis strategies obviously provide competitive advantages. Sharing Information and obtaining market analysis outcomes through the Web will provide business decision makers with up to date information and knowledge. This solution will not only reduce costs for business planning, but will also help to avoid the cost of wrong decisions.

Using the Web GIS-based DSS will help decision makers undertake automobile market segmentation to create a new vision of how particular markets are structured and operate, and will uncover the needs and wants of their targeted segments therein. Therefore, it is expected that use of the online system to conduct the B2B e-commerce will improve business planning processes in the automobile industry in the following ways:

- Better understanding of consumer needs in each of the segments, resulting in the identification of new marketing opportunities.
- Develop a market and/or advertising campaign to attract business in a particular market area or among a target market. Budget marketing expenses more effectively, according to needs and the likely return from each segment.
- Use precision marketing approaches. The company can make finer adjustments to the product and service offerings and to the marketing appeals used for each segment.
- Use specialist knowledge to enable the company to dominate particular segments and gain competitive advantage.
- Assist local dealerships with their understanding of the right mix of quantities for each type of vehicle. The product assortment can be more precisely defined to reflect differences between customer needs.

Developing the Web GIS-based DSS as an e-commerce solution could address broad benefit to e-business development from three aspects: .

Firstly, it uses existing Technologies in an innovative way. There is clear support for the development and use of GIS and Data Mining techniques for database marketing linked to company CRM systems [6]. However, while there is the potential for integrating these techniques within wider business process applications, this paper aims at bringing the benefit of information and knowledge exchange through B2B e-commerce to a diverse range of targeted automobile businesses, allowing decision makers to interact more efficiently with the information and the knowledge provided from market analysis and reduce the costs involved through

online solutions. The business model proposed ought to identify and overcome the barriers to e-commerce use by creating a platform for business growth and met the needs of automobile Industry.

Secondly, it leads to increased industry competitiveness. Use of the proposed online systems could help firms to generate revenue (through a better understanding of actual and potential market demand) and/or reduce costs (through efficiency gains). The proposed system uses maps and graphics to help communicate these results, enabling a distributor / dealership to see at a glance their current and target market shares (See Maps in Appendices). These results can be used by either an existing auto dealer or manufacturer, or by someone thinking of opening an auto dealership and trying to select the right geography and target market. All these courses of action would be expected to lead to increased industry competitiveness. The results of sales performance analysis in different geographical regions also provide relevant information to distributors/dealers, who can maintain an improved supply mix for possible demands of different brands and amount of sales in their business regions.

Thirdly, it delivers broad benefits e.g. reduced costs, improved information flows and efficient business processing. The cost of using market analysis information and knowledge in the manner proposed here is affordable for auto businesses when compared to the cost of employing or contracting a specialist. As the project will demonstrate, through the application of information technologies and e-commerce, small business can be helped to be successful and overcome their problem of inadequate market knowledge. Sharing Information and obtaining market analysis outcomes through the Web will provide business decision makers with up to date information and knowledge. This solution will not only reduce costs for business planning, but will also help to avoid the cost of wrong decisions for new entrants. The Information flow delivered to business decision makers could be improved through the advanced analysis technologies, analysis dimensions and time frames. Figure 1 illustrates some of these information flows, for example:

Information could be delivered to DMs using spatial and analysis technologies

- Overall analysis of automobile industry
- Sales by brand, time, and postcode
- Advertising expenditure by test drive campaigns
- Top sellers by postcode
- Difference analysis (by brand/time)
- Pump in / pump out analysis for a dealership's PMA
- Customer locations in postcode / CCD
- Demographic distributions in postcode / CCD
- Market potential within 20 minutes zones around service station, etc
- Information could be provided through different Analysis Dimensions:
- Time: current & historical market, future forecast

- Geographical Boundaries: (Market share in different Postcodes areas)
- Location Data: (Customer Locations)
- Demographics: Sex, Age, Income, Occupations, Number of Vehicles per Household, etc.
- Information for User-defined analysis scheme
- for example: combining different dimensions and/or VFACTS defined vehicle sales:
- Competitors market penetration for a model
- Selling patterns of one or many models

Segments and components analysis at a time frame for postcode areas

IV. Conclusion and Recommendations

Automobile manufacturers/distributors have been actively engaging in the transformation of the business using E-business technology. Renault's e-business case, based on the information from its Web sites, has shown that the company has gained the benefit and competitive advantage by adopting the following current e-business strategies:

1. establish online single point of contact for the e-business customers
2. establish e procurement system with trading partners
3. fully integrate the e commerce systems with its normal financial systems
4. establish customer information database from online information

Although direct sales of automobile products via internet to customer is still in the initiative stage. In the future, as business endeavours to develop e-business as the normal means of trading with customers and other businesses, there will be large cost efficiencies gained by the process of business reengineering. Examples of efficiencies will be standard product catalogues, simple online shopping facilities and direct linkages with customers.

In general, despite automakers desire to build relationships with Internet consumers, it will take time to do so because of existing dealers place distribution strategies, and the situation that dealers may be reluctant to espouse online purchasing for various reasons, including a lack of recognition for the need to commit to the channel and a fear

that the channel conflict.

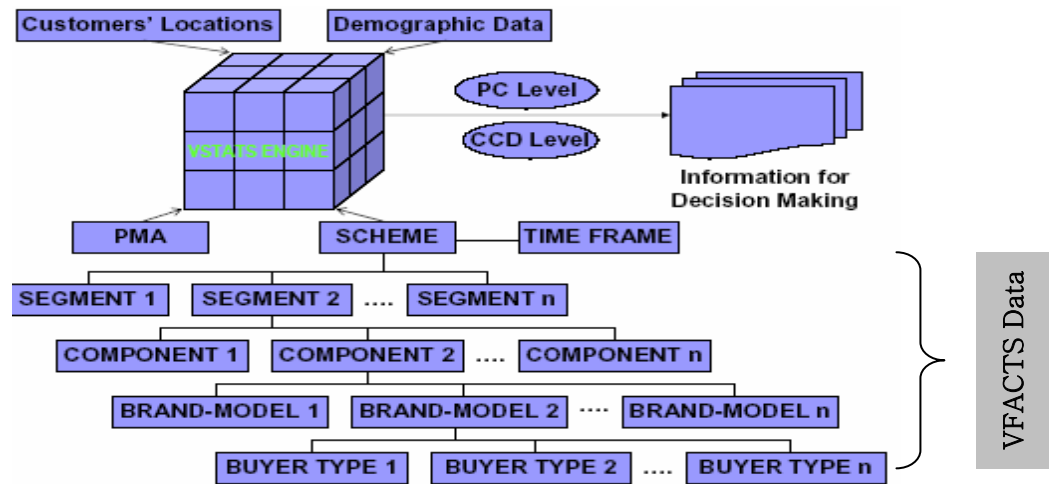
Successfully migrating to a click-and-mortar business model has been suggested as a major change, the direct-to-customer model will affect every aspect of a firm including channel and dealership management, customer segmentation, organizational form, incentives, skills, IT infrastructure, culture change, and a convergence of business processes, workflows, infrastructure, and data assets.

Furthermore, while there is the potential for integrating techniques within wider e-business process applications, this paper has argued on bringing the benefit of information and knowledge exchange through B2B portal e-commerce model to a diverse range of targeted automobile businesses, allowing decision makers to interact more efficiently with the information and the knowledge provided from market analysis and reduce the costs involved through online solutions. The business model proposed ought to identify and overcome the barriers to e-commerce use by creating a platform for business growth and met the needs of automobile Industry.

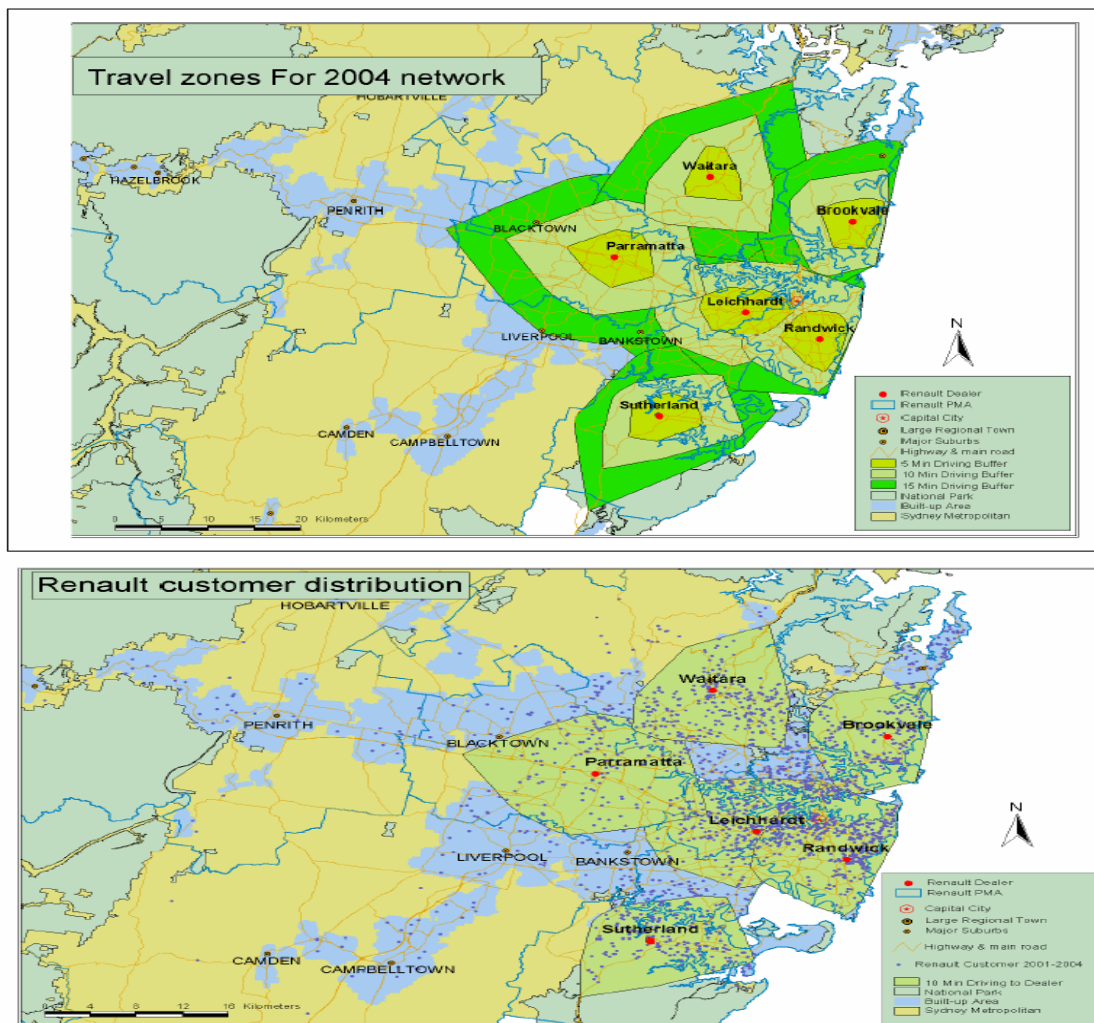
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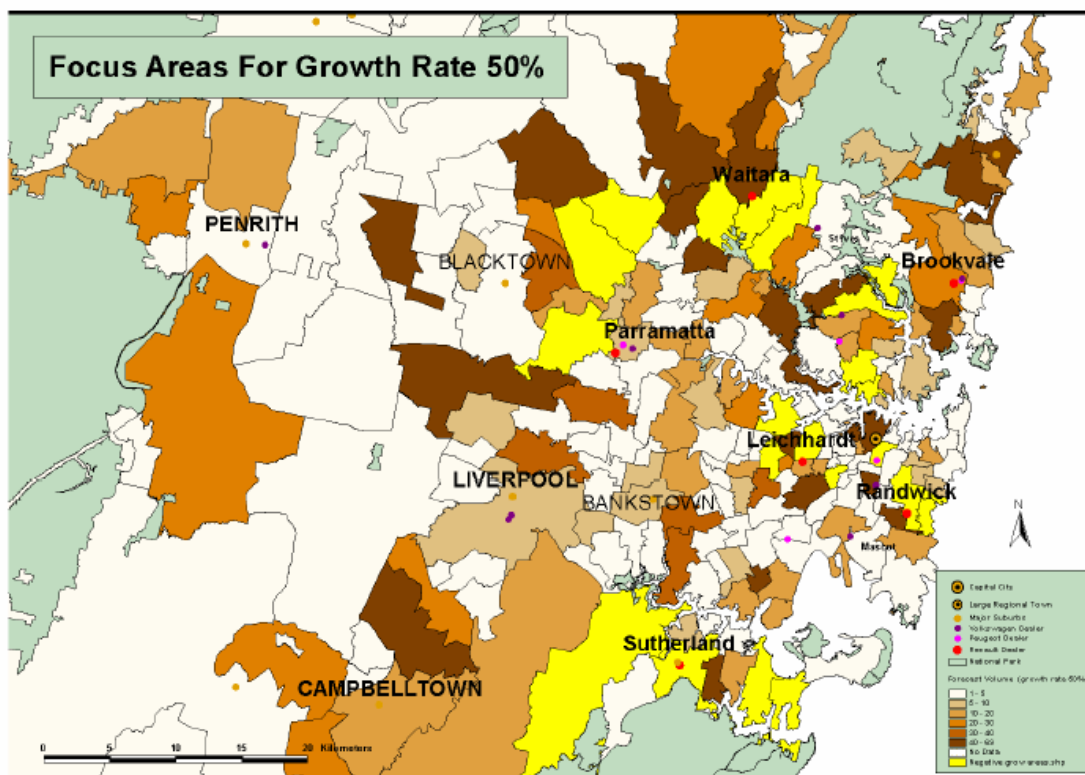
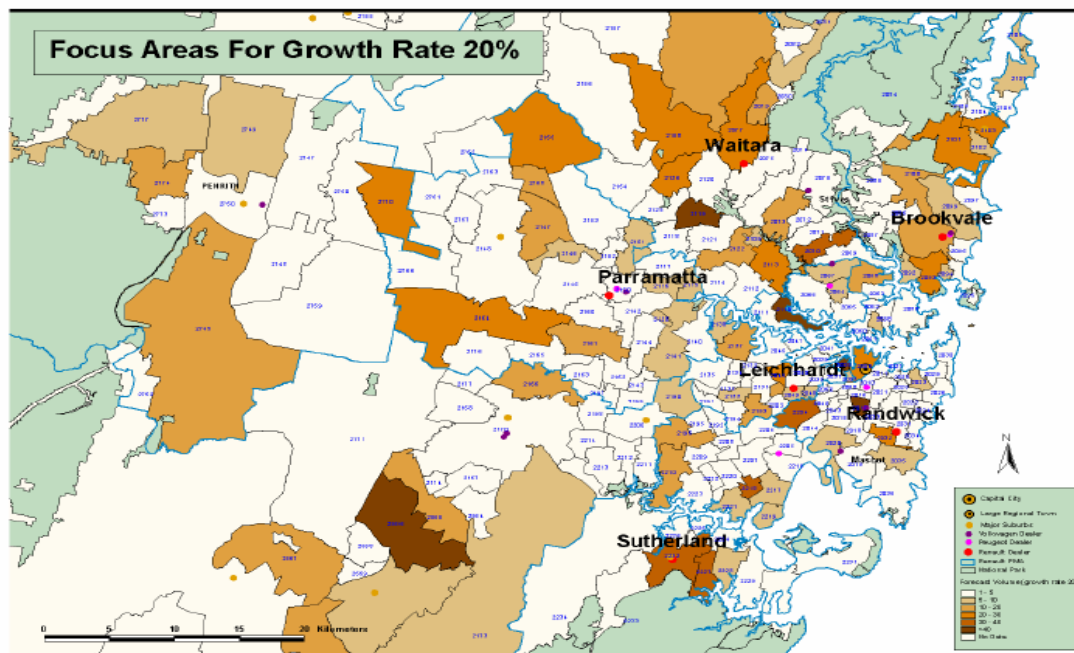
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Figure 1. Information Flows for Decision-Makers(DMs)



(Source: Mapdata, 2005)





Virtual Process and Data Flow: A Case Study

Nasrin Rahmati, Pankaj Periwal
Clayton School of Information Technology, Monash University
nasrin.rahmati@infotech.monash.edu.au

Abstract: The competitive global business has encouraged many organizations to save cost by moving to virtual processes. Virtual processes outsourced are completed by distributed teams in the context of matrix organizations. Projects are run by teams which are constantly changing in structure according to customer demands. Given the rapid expansion of business process outsourcing, it is important to understand more about the operations of these companies and this has not been very visible. This paper is a report on a case study of one virtual process completed by a vendor organization for a client company. The focus of the study is on the changes in the data during the process completion. The study examined the teams, their functions, their support structure and the outcome of the project. The study provides visibility of virtual process outsourced by the client organization.

I. Introduction

While Enterprise Systems were behind the move towards process oriented organization, outsourcing was the force behind a new type of organizational move towards virtual processes. 'The pyramid' - that is, the form for organization where strata of executives direct permanent divisions consisting of specialists fulfilling specific purposes is replaced by combination of different distributed teams working on different organizational processes. These are organizations built from projects, projects run by teams, which are constantly changing in structure according to customer demands. The driving force is that this type of organization as a rule cuts costs from the client's (the company outsourcing certain parts of its activities) point of view, and it also means that the work outsourced can be handled quicker and more precisely by the project oriented company towards the customer [1].

Expert knowledge is focused, and both the project oriented company and the company outsourcing parts of its business can concentrate on accumulating knowledge and focusing on their core lines of business. Project-oriented organizations have a linear structure at the top so that after the completion of a project the main team members refer to the linear structure to be provided with a new project for which they have to form a new team. The present study examines an outsourced business process which is a telemarketing project. The study examines a typical project, the team members, dataflow, reporting, and the outcome. The study examines how projects are completed and how

distributed team structure provides the required flexibility to complete a project on time and on budget. In the organization of our case study projects are called campaigns.

Primary data consist of interviews with people in key positions in the companies, notes from visits and information material used inside these companies. Secondary data have been collected from articles, books and the Internet.

The recent advances in Information Technology have enabled some of these project/matrix organizations to work with virtual teams. A successful example of cooperation between a local authority and a call centre would be the information service CALLskoga [2]. The information service, and the form for cooperation, is an example of a new approach, aiming to create a positive helix, spreading and in that way showing new possibilities and concretizing the use of new information technology for the town inhabitants.

II. Business Process Outsourcing

There are many reasons why companies outsource. It has been suggested that only those functions classified as non-core activities are outsourced. Outsourcing should be considered when certain support functions can be completed faster, cheaper, or better by an outside organization. It is believed that outside vendors possess economies of scale and technical expertise to provide these services more efficiently than internal departments. This is especially true about those functions for which there is an unclear value. Some of these functions are actually considered as overhead, or an essential cost but one to be minimized [3]; [4]; [5]. Many of these reasons are unique to specific firms and industries. Lankford and Parsa [3] believe that in the current environment of right-sizing and a focus on core business activities, companies can no longer assume that organizational services must be provided and managed internally. Managers relate outsourcing decisions to the organization's competitive business strategy. Companies have outsourced traditionally accepted non-core business processes (functions such as cleaning, catering, transport and facilities management) for decades to generate savings and to allow greater focus on core processes. Recent advances in enterprise systems were the force behind the use of 'best practice' in re-defining the organizations business processes. The combination of cost and efficiency consideration is motivating the organizations to follow the business model of retaining what's core and outsourcing processes that are considered to be non-critical [6].

Outsourcing has moved today to other areas such as

finance, HR, manufacturing and even call centres. Outsourcing non-critical activities saves a lot of management time which can actually be diverted to core business activities. Outsourcing is related to efficiency as well. Senior managers feel that even if they pay more for a task by outsourcing it, they know that the job will be done on time and also in a predictable fashion [3].

The economic downturn of the early part of this decade has forced the companies to try to reduce the cost at non-core processes. The best way to decrease the cost of such processes is to profit from the considerable wage discrepancy around the world. There are destinations such as India, China, Philippines, and Malaysia with highly qualified low-cost labour [7].

The last decade witnessed a rapid decrease in the cost of telecommunications due to various factors such as widespread use of Internet and the dramatic improvements in the supporting technologies. This in turn enabled the companies to re-define their existing business processes and execute whole or part of the processes in low-cost destinations [7], [8].

The potential for lower labour cost and greater efficiency are two important factors as companies consider Business Process Outsourcing (BPO). One of those two factors alone isn't enough to create sustainable value because skilled labour and technology are the most important cornerstones of any business process and both must be optimized to create lasting value and maintain a competitive edge. Industry analyst Gartner predicted BPO to grow to more than \$173 billion by 2007 [8].

III. Call Centre - Telemarketing

In call centre terminology, "outsourcing refers to the process of having all call centre activities handled by an outside organization or a teleservice outsourcer" [9].

Call centre are one of the biggest areas which businesses seek to outsource. In fact companies in the west have now started off shoring their call centres to countries like India, Philippines and South Africa. The reason for this is that most nationals in these countries speak English. The labour available in these countries is also comparatively less expensive. However we should be aware that outsourcing and offshoring would not have been possible if it were not for the advances in technology that have occurred over the past many years. The introduction of Wide Area Telephone Service (WATS) by AT&T in 1961 gave rise to toll free calling. The advances in telecommunications with cellular, wireless and satellite technologies have also boosted services. This has been further augmented by the Internet and the World Wide Web and the Computer Telephone Integration (CTI). This has also led many call centres to evolve to contact centres where basic telephone services are complemented by services in other media such as e-mail, fax, webpages, or chat [8].

Du Toit [9] has outlined many reasons why call centers are outsourced. The first of these is cost savings for the

company that outsources its call centre activities. Outsourcing can lead to lower costs due to economies of scale for the client company as the vendor is usually experienced and has the technology and resources that would usually be very expensive for the client to acquire.

Secondly, outsourcing results in reduced risks for the client. In many cases these risks are shared for the client as a result of consultation with an expert vendor.

The third reason outlined is scalability and flexibility to the client. Depending on the amount of work that the client has at a particular moment, casual staff can be taken on or laid off by the vendor as required.

Lastly, outsourcing allows process re-engineering and implementation of best practices benchmarked against similar operations worldwide. As many call centre outsourcers tend to utilize the most advanced technology available to stay efficient, the client gets access to new systems and applications which may otherwise have been unaffordable.

Telemarketing is one of the largest outsourced services in the industry today. According to Spiller and Baier, "Telemarketing is defined as a medium that uses sophisticated telecommunications and information systems combined with personal selling and servicing skills to help companies keep in close contact with present and potential customers, increase sales, and enhance business productivity."

Telemarketing is a direct marketing tool which allows organizations to reach their customers in a personalized manner. Telemarketing allows for personalized selling without the face-to-face aspect. Telemarketing also is the most effective medium of direct marketing. In the USA, telephone marketing sales for both business and final customers accounted for \$764.9 billion in 2003 and these figures have risen tremendously.

Telemarketing has the advantage of providing immediate feedback and is also very productive. More customers can be reached over the telephone in a given period of time than by having to send a sales representative to each individual customer. The telemarketing industry has one of the highest labour turnarounds because the nature of the job involves frequent rejection and intense personal interaction.

Technical Issues

Telemarketing can be classified as **inbound**, where customers call to place an order, to request for more information, or for customer service, or **outbound**, where a firm calls customers to offer a product or service.

Outbound calls are referred to as proactive telemarketing. The company wanting to sell a product or offer information about a product initiates the call. Outbound calling requires more experienced and well-trained employees as compared to inbound calls.

Outbound calls can further be classified as cold calls and warm calls. Cold calls are made when there is no existing relationship with, or recognition of, the direct marketer [9]. Warm calls on the other hand are made when there is an

existing relationship between the prospect and the direct marketer.

Major technologies have been developed to support the telemarketing industry. Apart from the ones outlined above, there are two more systems that are very critical. These are the Dialed Number Identification System (DNIS) and Automated Numbering System (ANI). The DNIS identifies for the receiver what number was dialed by the caller. This may help organizations to keep track of the number of calls that are dialed to a particular number and thus companies can forecast the number of employees that are needed to handle call on that line. The ANI identifies the telephone number of the person calling. This number can then be matched against a name in the company's database so that all details of the person calling can be populated when an agent actually speaks to the person calling. This can actually save a lot of money for the organization in terms of the amount of time an agent spends speaking to a single customer.

Another very important technology for outbound calling is the predictive dialer. The predictive dialer is a computer that actually dials calls and connects this call to an agent who is free only if a live person answers the call on the other side. It is considered to be predictive because it anticipates when an agent will become available, and when the next human response will be detected [10]. The predictive dialer greatly improves efficiency by maximizing the amount of time agents spend speaking to customers.

A well planned telemarketing program requires that the telephone operators are well trained and also they are provided with well designed scripts. "A telephone script is a call guide to assist the telephone operator in communicating effectively with the prospect or customer" [9].

It is suggested that in Business Process Outsourcing the person or the team who manages the day-to-day relationship with the outsourcer plays a major role. This person or team needs to understand the companies own strategies as well as how the outsourcer operates and would be the source of all communication between the outsourcer and the organization [11].

IV. This Study

Outsourcing literature in Information Systems does not follow any single research question or a single method or theory. It has been suggested that from an academic perspective, the practice of outsourcing IS functions is a practitioner-driven phenomenon [5]. This is illustrated by the fact that the first research papers on the subject did not appear until 1992, over three years after Kodak's landmark decision to outsource its IS functions [12].

The present study is an interpretive study. These are studies that seek to understand the deeper structure of a phenomenon through different approaches such as trying to understand the meaning an act has for the actor himself, trying to understand the observed world reflected by written or spoken text, or trying to understand the meanings that a

particular behavior signifies to the subjects [13]. According to Orlikowski and Baroudi [14], in interpretive studies researchers adopt a non-deterministic perspective where the intent of the research is to increase understanding of the phenomenon, and the phenomenon of interest is studied in its natural setting from the perspective of the participants. For that purpose, in interpretive research often case studies and action research are used. The aim of such research is to get close to research subject and explore its detailed background and life-history [15].

Case studies typically combine data collection methods such as archives, interviews, questionnaires, and observations [16]. Case studies are frequently used to explore a problem that is not well defined or understood [17]. This method helped us collect information on a particular campaign in a particular setting that could not be otherwise collected.

The project (campaign) was divided into different sections. Different groups of people concerned with the campaign were interviewed. The study used interviews in combination with observation of the teams involved in the operations of a selected BPO in the outsourcer settings. Interviews, observations, and archival sources are particularly common in case study data collection since they provide a stronger substantiation of constructs [16]. The observation of the particular business process involved taking field notes on the role of different teams and the changes to the original data provided by the client organization.

This study was conducted over a period of five months. Most case studies are conducted over a fairly short period of time—usually less than a year, although it is possible to conduct a case study over a much longer period [17].

The Project (Campaign)

The present study focuses on the changes in the data through one outsourced project to a vendor. The selected vendor organization is a medium sized organization with a combination of temporary and continuing staff of about 3000. They are located in three locations in South East Asia. They offer services from initiating and receiving the end customers' calls, to managing the entire back office and support services common to most organisations. In view of their particular organizational structure they can tailor solutions to suit their clients' needs. Each provided service is flexible and can be used independently or in association with their other offerings. Figure 1 shows the basic structure of the selected organization pointing out the support structure available to different virtual processes run by this organization. For the purpose of this study outbound telesales campaign was selected as the outsourced process.

A telemarketing campaign is a project. The external party is the client who has outsourced the telemarketing campaign. The internal team members are the divided into two groups. Those who are working exclusively on this campaign, we call them *campaign members* and those who provide services to support all running campaigns, we call

these *service members*. At the beginning of the campaign the campaign manager would be provided with Business Requirement Specifications (BRS). The BRS would specify the KPIs, the number of hours a campaign needs to function, number of staff and also the criteria for QA involvement. The BRS would also give an indication about the script.

The data would be reviewed by the Implementation Manager so that s/he can arrange for the right set-up before the campaign is up and running.

At each point of time there are several campaigns running simultaneously in the telemarketing company. The number of outbound telesales is approximately 10 separate campaigns with their own campaign. The following are the campaign members:

The Teleoperators: At the bottom of the ladder and have to meet some standard KPIs for each campaign. **KPI** stands for Key Performance Indicators are set by the client to be achieved during the course of the contractual period. These are directly related to agent productivity. Clients prior to venturing into a partnership with an outsourcer build their own business models assuming the level of productivity required to make the venture viable.

The Group Leaders: each campaign has several group leaders who are usually in charge of five to six teleoperators.

The Campaign Manager: Each campaign has a manager who has usually worked as a group leader for several years.

The following are the *service members* who support all running campaigns.

The Quality Assurance group: These are the group who are in charge of checking the quality of any agreement made on the phone before the positive results are considered as a success.

The Information Technology Services: The unit is divided into different sections. These include Business Analysts, Infrastructure, Voice (outbounding diallers, enterprise routing and voice portals) and the CRM Application.

For a specific campaign, the customer data (records such as their phone numbers, name, the product type and age) is provided by the client company. This data is sometimes sent from a washing agency to ensure that all the data being sent is correct and that things have been matched up. Washing means checking the quality of the data before they actually dial the number.

IT would do all the validations on the software to ensure that the flow of the scripts and data is all correct. There are two type of software used here. The first one is CRM software and the second one is the software which is directly connected to diallers. The data provided is then stored in two databases, the CRM and the database connected to diallers. In the database which is connected to diallers, we store information like the phone number, the customer ID and the campaign ID. The project company has a unique code for each campaign and customer for that campaign. In the CRM database all information about the customer including call history is stored.

The data for a campaign is provided in an RTF file. The project company then provides a campaign number for that list and the script for CRM is configured. Also a customer ID specific to the project company is provided for each customer in the database. The script in the CRM software is dynamic as there are many script variables which get loaded based on information in the its database. The client provides the script which is then formatted by QA. IT then converts the script to the right file format to be uploaded into the software.

The project company through IT has access to two kinds of diallers. These are Predictive and the Progressive dialler. The predictive dialler is the one most often used and it results in higher productivity. The trade off with predictive diallers is that it can result in drop calls. The progressive dialler is not used very often. With this, one dial is made for every agent waiting. It may not result in an efficient hit rate. The CRM software is independent of diallers. The diallers use their own specific algorithms to dial. The speed of the diallers can be altered based on the time of the day or the requirements of the campaign. The dialler usually throws a call to an agent who is free when it makes a hit. The call outcome is reflected both in the CRM software and the database connected to diallers. The CRM software is updated based on the diallers' database call outcome or the diallers' database code for the call disposition.

Analysts would be concerned with the scripts and how script variables are loaded on the software. They are also concerned with productivity and KPIs. They support the campaign manager achieve the desired KPIs. They make sure that the scripts are ready for a campaign on time. In addition they help campaign manager by controlling factors like wait time of agents, their talk times and the wrap times. Analysts are also concerned with resource planning and forecasting. They are more concerned with the results of the campaign.

The CRM database contains all information about the customer. The diallers' database is concerned with the call outcome of each call dialled.

Training Services: We noticed that the training team is in charge of training members of different campaigns. They obtain all the information required for training different campaign members. They train different levels differently. There are some basic training workshops for the campaign managers, group leaders and operators which are conducted in separate sessions. They divide the training workshops into two sections, the sale section which they cover and the product section that in some cases they conduct the workshop on the basis of the material provided by the client and in some particular situations the training is covered by the outsourcing organization themselves. There are several campaigns running simultaneously. This means that the training team are conducting workshops for different teams and different levels in each team all the time. In training sessions of the group leaders and the training sessions of the operators the specific information is provided by the campaign manager. This is on the basis of the expectations

of the client.

Quality Assurance: Quality Assurance (QA) team have two different functions. One is toward the client (the outsourcing organization) in terms of meeting the targets and the other is to ensure that the project organization abides by rules and regulations. This could be the Fair Trade Practices Act or the FSRA for financial products. QA is the team who ensures the Service Level Agreement entered with the client is met. From an organisational context, they make sure that the project organization obeys rules. From a campaign context, they make sure that the business follows client specific targets. It is interesting to note that QA is not really a legal team. They work on the presumption that scripts and expectations given by the client have been checked by a legal team. They document what the client expectations are.

It is important for QA team to have a right definition of the successful call for each campaign. The criteria are given to the QA team by the Campaign Manager who deals directly with the client. The criteria can be very specific to a campaign. Some of the criteria for a specific campaign may be relevant to the way the script is read by the operator, the number of rejections on one call, background noise, mistakes or incorrect or missing information, and that customer to be told s/he is being recorded.

QA's communication with the campaign manager is very interactive. In different campaigns, QA provide essential support for the campaign manager. QA would support campaign manager in areas such as recruitment process; rewards and recognition, hours of operation. In the particular project examined in this study QA team provided the campaign manager with support in: Call monitoring and making sure mistakes are corrected, Verifying or bouncing sales and then providing feedback on what went wrong, Direct feedback to operators on the campaign and performance reviews to address any problems.

Outcome – Reports: Once the call is considered to be successful, the result will be checked by QA team for quality and then sent to the client organization. The day after the successful call all the necessary documents regarding the sales will be sent for the customer by the client organization. The outcome for the project organization is updated database to be provided for the client organization upon request and different types of reports. When a call is successful, it gets documented in a system (in-house). The details that are stored here are information such as Customer ID, Customer Name, Name of operator who was responsible for the sale, Length of recording, Campaign ID, Bounce reason if any and QA comments if any.

Data Flow: The database is updated on the basis of the responses by the customers. The response to the calls made is sent as daily reports to exclude the name and details of the customers already purchased the product/service. This will avoid calling the same customer for the same product/service.

Operational: The extract of a successful call is sent to the client the day the sale has been made. The client is responsible for sending the policy document. Also the

Product Disclosure Statement (PDS) and Financial Services Guide (FSG) are sent to customers by the client.

There are two types of reports, external reports and internal reports. External reports are provided by the project organization for the client and internal reports are for the management of the operation inside the project organization.

External Reports: Reports to the client can be of different types:

- **Daily Activity Report:** This summarises sales, hours, dispositions (the result of the call), and productivity level on day in comparison to month or week.
- **CSP:** Every operator productivity level on a daily basis in comparison to their monthly results.
- **Age Summary:** This report is important in Financial Services. It would be used as a data mining tool to connect age with the number of successful calls. This will help the client company target the correct age group for their future campaigns.
- **Premium Levels and Card Types (specific to the project of this case study):** This report matches premium level to Card Type of the Customer. This is also used for data mining purposes. This will help the client to focus their future campaign target the right market segment.
- **Daily Extract:** This report contains data for sales of the day. It would contain information such as which customer signed and at what level and what price, who sold the cover, what time it was sold and the customer ID.
- **End of Campaign (EOC):** This would be accumulative data about the performance of the campaign. The call outcomes are summarized in the EOC.

Internal Reports: Internal reports are for people within the organisation and are usually less cosmetic. These reports are usually system generated. Internal reports can be intra-day, daily, weekly, monthly and end of campaign (EOC).

Figure 2 maps out different steps completed in each virtual process completed by this organization as a vendor organization.

V. Discussion

The study selected one outsourced process of a vendor organization with matrix organization and followed the dataflow through this particular process. These organizations are usually experienced in a particular business process and have the technology and resources that would usually be very expensive for the client to acquire. The vendor has a project oriented structure. The project oriented organization is ideal for this type of organization and in practice it saves their clients time and money. In most cases such as the project examined by this study permanent team members were acting as business analysts on behalf of their clients. The building block of these organizations are virtual teams who work on a particular campaign.

The vendor organization usually can work on a very low cost due to the economies of scale and particular characteristics of this type of organizational structure. The

lowest rank on the ladder of team members have a very standardised work. All the questions are coded. All the possible outcomes are coded too. This is a very standardized work. The calls are automatically dialed and then automatically directed to the operators. They do have all the questions and answers. Once the sales is made the result is checked by very standardised process by QA members and forwarded to the client. The cost is kept very low. The process is completely standardised. For each campaign the values of the parameters are changed according to the requirements of that particular campaign and by the end of the campaign all the right information have been forwarded to the customers by the client. The only remaining function would be to provide some additional information for the client to be used in their future campaigns.

The study documented a sample virtual process from the data provided by the client organization to the completed reports and the updated database sent for the client company. The next step would be to look at this whole process from a knowledge management point of view and to examine different concepts in such a virtual process such as data ownership and security.

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GLOSSARY

- **Abandoned call** – A call that customer hangs up before even speaking to an agent.
- **Agent** – see TSR.
- **Calling List** – A table containing information regarding customers to be called.
- **Campaign** – An outsourced telemarketing venture for a specific client.
- **CM** – Campaign Manager. A person/s responsible for the day to day activities concerned with a campaign at the outsourcer.
- **Contact Penetration** – A KPI which sets the percentage of contacts to be achieved based on the number of records provided in a list.
- **CPH** – Contacts per hour. A KPI which sets what is the minimum number of contacts that an agent needs to make in an hour.
- **CTI** - Computer Telephone Integration. Technology which allows the telephone to be integrated with the computer.
- **Disposition** – A call outcome. After a call to a customer is finished with, the outcome of the call is saved in the form of predefined dispositions. Examples of dispositions would be Answering Machine, No Answer, Call Back, Sale, etc. The dispositions are set either by the predictive dialler or the agent with the help of conclusion codes.
- **Dropped call** – A call that is answered by the customer but cannot be answered due to agent unavailability.
- **EOC Reports** – End of campaign reports. These summarise all the activities during the course of the campaign and provide figures for the client who can compare them to the KPIs they have set.
- **Extract** – A record of a particular customer from the calling list.
- **FSG** – Financial Services Guide. A legal document which is mailed to a customer and contains information about all the parties involved in providing a financial product to the customer over the telephone. It has to be mailed to a customer before he/she can be contacted over the phone.
- **Hit Rate** – The contact to dialled rate.
- **IVR** - Interactive Voice Response. A computerised system that allows a telephone caller to select an option from a voice menu.
- **KPI** – Key Performance Indicators. The specific factors that the client sets its business partner to achieve during the course of the contractual period. These are directly related to agent productivity. Clients prior to venturing into a partnership with an outsourcer build their own business models assuming the level of productivity required to make the venture viable.
- **PDS** – Product Disclosure Statement. A legal document which has all description about a product being offered over the telephone including costs, eligibility, exclusions, etc. It has to be mailed to a customer before the customer is contacted by telephone.
- **Predictive Dialler** – A computerised systems which dials calls from a list and only forwards those calls it thinks to be a valid answer to an agent on the floor. If it cannot find an agent to forward the call to, it simply drops the call.
- **QA** – Quality Assurance. A department at the outsourcers end which is responsible for verifying the legality of recorded sales.
- **SPC** – Sales per contact. A KPI which sets what is the minimum percentage of sales an agent needs to achieve based on the number of contacts made.

$$SPC = (\text{Total number of sales} / \text{Total number of contacts}) * 100$$
- **SPH** – Sales per hour. A KPI which sets what is the minimum number of sales an agent needs to make per hour.
- **Telephone Script** – A call guide used to assist an agent to communicate effectively with a customer.
- **TL** – Team Leader. A person who manages a small group of agents and is responsible to see that agents belonging to his/ her team are meeting necessary KPIs.
- **TSR** – Telesales Representative. An agent who takes calls forwarded by the dialler and speaks to the customers

An e-Enabled Service Value Network for the Pharmaceutical Industry

John Hamilton *, Willem Selen **

* James Cook University

Cairns Qld 4870 Australia

Tel: 61 7 4042 1091 Fax: 61 7 4042 1080

Email: John.Hamilton@jcu.edu.au

** Macquarie Graduate School of Management

Macquarie University NSW 2109 Australia

Tel: 61 2 9850 8984 Fax: 61 2 9850 9019

Email: willem.selen@mgs.edu.au

Abstract: Across Australia the pharmacy industry is undergoing major reform and re-structuring. Emerging technologies like e-pharmacies, new low cost players, pressures from supermarkets, doctors, consumers and politicians have changed the nature of this industry. Such pressures are causing the industry to unite, to draw all its component players together, and to deliver a new disruptive solution set that will likely radically change the status of competition. A service value network (SVN) framework is discussed as the likely scenario, and its major underlying dimensions are detailed. Such a SVN approach may eventually lead to better strategic alignment, higher industry performance (capabilities and delivery), greater value-adding solutions, increased customer satisfaction, and more competitive pricing.

Keywords: E-Business Models and Enterprise E-services Architectures, network, e-pharmacy.

I. Introduction

Recent research by the Siegel [33] at US Sloan's School of Management indicate that all players in an industry benefit from aggregation or sharing of information, ideas, and knowledge. They suggest a wealth of knowledge may be garnished by combining organizational expertise. Aggregation analysis delivers relationships with greater combined competitiveness. It was further posited that it is prudent for organizations, like the pharmacy industry, to consider their e-strategy, and to add aggregated information and knowledge capabilities into their competitive frameworks [33],[38]. This supports emerging new business models involving multiple aggregations like e-pharmacies, and the proposed concept of a service value network (SVN).

Emerging technologies often deliver disruptive solutions that may radically change the status of competition [5], [11]. For example, e-pharmacies, networked medical services, direct customer targeted solutions, fully integrated supply chains, logistics solutions, and other efficiencies constitute genuine threats to existing pharmacy industry business structures. In particular, competitive threats from Australia's supermarkets, the Australian Medical Association, and the

Australian Consumers' Association are encroaching on the pharmacy industry, with the aim of opening up this traditionally protected pharmaceutical industry allowing free and open competition. One way in which the industry has responded is through the creation of e-pharmacies. In our research an e-pharmacy may be defined as a virtual shop front pharmacy, often working collaboratively with a physical pharmacy outlet to enable rapid selection and distribution of customized and generic pharmaceuticals and associated products. Since 2000, four major e-pharmacies ePharmacy.com.au; HomePharmacy.com.au; PharmacyOnline.com.au; and PharmacyDirect.com.au (see appendix 1). have emerged in Australia.

This emerging business model creates new challenges of value creation and modes of interaction for customers. Of particular interest is the notion of the underlying service value network (SVN) [16],[17] and its partners, and dimensions and issues that shape its customer interface, service offering, and enabling service delivery system; the identification of which will be the focal point of our research.

The service value network (SVN) in an e-pharmacy setting is hereby defined as a collaborative network of supply chain partners (such as pharmacists, drug companies, distributors, beauty care suppliers, health and natural product suppliers, medical practitioners), sales channels (website e-sales, direct over the counter sales, and referrals), operational and network administration personnel, and customers.

This research identifies major dimensions, drivers, and enablers underpinning the development of a holistic SVN for e-pharmacies. Currently, service offerings are delivered through individual stores or groups of stores, and are largely dependent on the communicative skills of the sales, or front counter, person. A SVN complements, enhances, and value adds to this solution. It is designed as an information storage and retrieval system that is 'datamined', prioritized (deploying approximations using fuzzy logic), and has the capability to deliver additional customer information. Such information may then be used to enhance the dialogue between the business and the customer. Service related value added solutions may include: relevant drug options, possible co-drug side effects, packaging options, consumer allowable limits, claim options, delivery options, nearest doctor, hospital, medical insurance options, tax benefits, local preferences, etc. In addition, this data is directly accessible

via the pharmacy industry website where customers may source/request annual tax return data, doctor's surgery bookings, local hospital information, health and pensioner claims, and the like.

Figure 1 displays a global perspective of the industry, and the capabilities required from a SVN. Here a national data storage solution is developed that may be accessed by individual stores, store groups, store chains, or e-pharmacies. Development of such a SVN solution requires industry-wide information sharing, and will eventually lead towards cost savings and enhanced value propositions [16],[17].

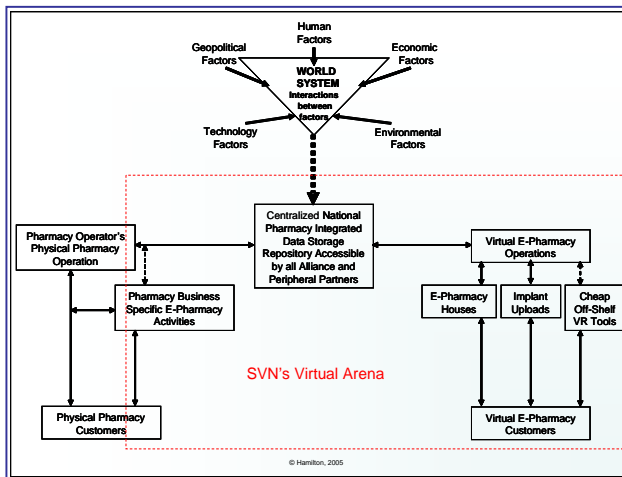


Figure 1: The Service Value Network – Global Perspective (adapted from Anwar & Hamilton [1])

The SVN is designed and managed by a central SVN coordinating group, which in a pharmacy setting might be taken up by the National Pharmacy Guild. Another example is the Australian Tourism Export Council for the Australian Tourism Industry, which is currently compiling a national database in preparation for linking up its industry partners under a SVN-like framework. The generic SVN model is detailed in the following section.

II. Service Value Network

The service value network for the pharmaceutical industry is comprised of a service strategy that drives three dimensions of the virtual service encounter: the services provision, customer targeting, and the underlying operational IT-infrastructure. In turn the virtual service encounter may interface with the physical, when a sales assistant accesses the database, for example to fill in customer prescription details, or to access specific drug information for the customer.

Interactions within the SVN can be viewed from an internal business perspective among supply chain partners in delivering and fulfilling customer orders, for example, a pharmacist replenishing out-of-stock items. On the other hand, the SVN responds to external customers such as a local nursing home initiating bulk drugs supply directly via the SVN. Both internal and external perspectives need to be

considered separately, as they need to be aligned in order to accurately respond to customer needs.

The proposed generic SVN model is displayed in Figure 2.

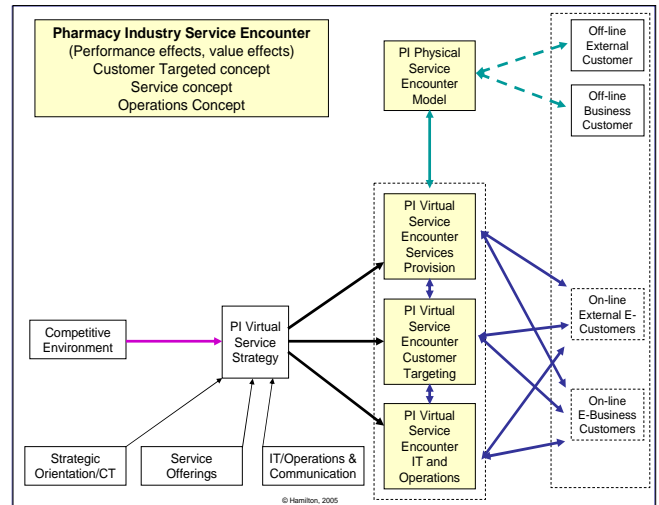


Figure 2: Service Value Network (adapted from Hamilton, [15])

III. Service Value Network (SVN) Dimensions

This paper aims at identifying the various dimensions of the SVN, such that designed service provision, customer targeting, and underlying IT and operations infrastructure are aligned with the set service strategy. The underlying dimensions can be grouped as follows:

1. the impact of competitive environment on the industry.
2. the dimensions of IT/operations and communications, integrated customer targeting systems, and service offerings in determining an industry strategy as set by the SVN Coordinating Group.
3. dimensions of the service delivery system within a virtual network, and the impact of virtual network delivery on potential service performance.

Each of these dimensions will now be discussed below.

IV. Competitive Environment

The competitive environment, displayed in Table 1, is influenced by external forces. It may be enhanced strategically by becoming a first mover, by differentiating, by focusing on specifically defined niches, by being the low cost provider, or by being the dominant player.

The industry strategy will need to be developed, such as to having the agility to adapt quickly to governmental rule/regulation changes. In the pharmaceutical industry this may relate to i.e. new packaging regulations. The SVN will

also need the capability to respond to changes in levels of competition. An example in Australia is the recent introduction of pharmacies within low cost retail chain stores/supermarket chains. In addition, the SVN requires the ability to create and work in supplier partnerships to either capture particular capabilities, or benefit from operational scale effects. As the health care market is growing rapidly because of an aging population, scale effects may become increasingly important. An example is the integration of specific health insurance cover information with pharmaceutical prescriptions.

The SVN should stay abreast of technological evolutions and keep its technological capabilities aligned with its customer and competitive requirements. Furthermore, customers become increasingly better informed and demanding. The pharmacy industry may respond by enhancing its service offerings and/or reaching the customer through various response channels. An example is the recent development of on-line medical encyclopedias in e-pharmacies.

Table 1: Competitive Environment

Competitive Environment	
Dimension	Operational Characteristic
Political	Speed to adopt governmental rule / regulation changes
Economic	Capability to respond to competition changes; Efficient cost conscious scaling of operations
Environment	Respond to competitive changes; Respond to new innovations
Cultural	Cultural monitoring of Cultural targeting
Technology	Industry wide; Networked solutions; Latest offerings; Quick accurate responses

Inputs to Industry Strategy

The Inputs to the pharmaceutical industry strategy are displayed in Table 2. They have a vital connection to the virtual service encounter. If the strategy is one of low service integration then the business will not be delivering high levels of value added service, but rather will deliver more standard service offerings.

Table 2: Inputs to Industry Strategy

Inputs to Industry Strategy	
Dimension	Operational Characteristic
Corporate	POS related Initiatives; Market positioning; Degree of service networking
Competitive	IT capability; Customer understanding; Range of service offerings
Financial	Networks; Customer knowledge; Services offerings
Customer Targeting	Customer demands met; Communicate culturally; Datamine stored information
Service	Industry wide; Networked solutions; Latest offerings; Quick accurate responses
Technology/IT	Customer delivery; Customer analysis; Customer services
Environment	Reactive to business changes; Reactive to customer changes; Updating continuous

Partnering businesses throughout the virtual service value network, position themselves strategically among competitors. They align their strategies internally with fellow value network partners and work towards a common set of strategic goals.

The supply chain side of the physical and virtual service network encounter becomes a cohesive partnership of integrated players working collaboratively as a network. Immediate competitors either mimic aspects of the service network approach, or develop their own solutions. Hence, new points of difference and competitive strategies emerge. Alignment of the service value network, with its alliance partners, to a common set strategic goal and a balanced set of strategic performance measures, is paramount.

Three major classes of inputs to the service strategy are: the underlying IT and operations / communications infrastructure, the customer targeting system, and the service offerings to be delivered. Each of these are detailed below.

IT/operations and Communications

This encapsulates the technical areas of software, knowledge management, business intelligence, and communications. The system must be capable of delivering the demanded customer requests, and of interpreting the request and delivering sensible added value complementary features to the customer.

Since the late 1990's, the five largest software providers: HP, IBM, Microsoft, Oracle, and Sun, in conjunction with a few innovative new entrants, began promoting new standards, new web services platforms, and new activities environments. The internet protocol version 6 (IPv6) software [7], Microsoft's '.NET' and IBM's WebSphere have offered new potential for communication and business operating systems platforms, which may further enhance the virtual environment. In addition, new ways to interpret, interrogate and deliver customer requirements are unfolding, and 'intelligent', responsive websites are emerging. Future applications, such as temperature sensors in clothing linked to illness monitoring devices, may represent yet another possible application area of intelligent information sharing.

In order to enable a value-add virtual encounter with customers, it is paramount that the overall process is driven by top management. IT investments need to be made for building integrated IT networks in order to improve connectivity with customers, and information delivered to customers. The resulting service offerings and customer targeting practices use numerous channels, such as internet, email, SMS, POS transactions, and supply chain partner referrals. Moreover, the IT infrastructure needs to be agile to respond to changes in IT requirements.

Customer Targeting System

The knowledge and data capture concerning the customer is crucial to delivering appropriate services. Site personalization and high levels of recognition may enable the business to enlist its affiliates and jointly target the customer. It may also deliver the identification of new

markets.

The service network customer encounter dimensions include the internal business-to-business customers and the external business-to-end users (or customers). Frohlich & Westbrook [14] have researched some internal business-to-business customer effects, but the business-to-consumer dyad has not been empirically studied [4].

The customer, marketing and advertising based studies have investigated websites with a view to determining effectiveness [2]. Rohm & Sultan [29] have explored strategies to increase customer engagement (time), and thereby strengthen brand-customer relationships. Others [6] in conjunction with their channel partners, have attempted to match the urgency (or criticality) of their customers' varying needs. They aimed to develop buyer life-cycle ownership value, and to deliver intensively loyal groups (segments) of customers. Still others [20], recognized that virtual business solutions (including website purchasing) are moving towards customer empowered, on-line, self paced, exploration of the service (or product) variations, prior to purchase. The customer's readiness to adopt new service value chain approaches also varies, and some customers may desire website interactions that are 'tailorable' to their actual customer requirements. The modern day customer is increasingly more demanding of the business, and its service provisions. Cross [9] suggests over 50 % of consumers are too time-pressurized to enjoy traditional shopping. Foley [12] says this time shortage necessitates targeted, personalized communications specific to their individual needs. Wolfe [37] suggests the statistical averaging of customers is the most failure-prone fault-line in transactional marketing. Hence personalized solutions remain a key to customer targeting. For example:

1. Similarity and dissimilarity [30] – where dissimilarity leads to dislike. Here need satisfaction [8] (where sexual, social and financial needs require matching), and a pleasant experience [23], contribute to the two way communication;
2. Exchange – where the complementary emphasises of value partners contributes to the relationship [36];
3. Human courtship – where targets, goals and the risk of non-compliance of the participants must converge [3];
4. Impression formation – where the emerging model captures first impression or 'wow' factor, incorporating the scripting of information and the richness of the media incorporated [24];
5. Flow theory – where 'perfect dialogue and merging of actions between participants exists [18];
6. Business networks interaction – where the flow of information between participants calibrates the relationship between them repeatedly [13];
7. IT interactions and personalization – where clarity, personalization, trust, dynamic adaptation of content [22], visual systems (that deliver and adapt

to continuously change information) [19], and a full range of text, video, audio, and graphics that deliver real-time 'telepresence' [34] – where the customer is mesmerized for a time [18] are evident.; loyalty and retention interactions – where the business must understand and react to their target market.

Rigby [28] evaluated spending patterns and consumer loyalty and concludes businesses cannot break-even on one-time shoppers' solutions. Customers must be empowered, seduced and converted into lifetime relationships [31]. Feedback loops [21] to direct marketing, and targeting most valued customers, can increase both customer loyalty and retention [27]. Customers demand more reliable services and products, and they expect to have their needs met in shorter time frames [10]. This customer perspective is dynamic and subject to change [32]. Consequently, the business must become agile and more capable of delivering what the customer needs and wants [35].

Customer targeting in a pharmaceutical setting first and foremost focuses on a broad understanding of what customers desire, requiring continual collection and mining of customer data and customer activities. The SVN approach takes this market research information not only to target and better market for specific customer segments, but also to broaden its service offerings by leveraging the unique capabilities of supply chain partners. As such, knowledge building of the customer base is a key activity within the SVN, either directly by the central SVN coordination group, or by sharing information by supply chain partners. Information on customer connectivity and relative use of channel medium are analysed as well.

Service Offerings

The decision as to the level of service is vital to the business. The levels of networking, agility, flexibility, customer targeting, and business supply chain focusing will vary depending on the choice of strategy. The quality of the service, the extent of added value offerings, the level of external partnering, the degree of environmental response, and the like contribute to this dimension.

The virtual strategy for specific service offerings could generically follow the traditional strategy classification by [25],[26] of differentiation, focus, and cost, in addition to a strategy based on flexibility/agility. This in turn will have an impact on the resulting service offerings and their respective customization. The business may be an innovator (like eBay.com), an early adopter (like RealEstate.com), a follower (like Zuji.com), or even a bandwagon copier (like many government departments). In today's highly competitive global environment many models exist, but the business must maintain some points of difference, or risk being out-competed. As such, the pharmaceutical industry may take on a role of innovator, leader, or follower in the underlying technology that enables that particular service offering. For example, a new Australian pharmacy chain

called ‘V’ Pharmacy is developing a service value network approach as its competitive focus. It is surveying the industry, its customers and the general population to set the frameworks from which it will deliver its customer-centric offerings. It aims to deliver highly personalized solutions in conjunction with its pharmacy script medicines. These will include detailed medical information, optional treatment approaches, linked ‘Medicare’, health and tax related data. This information will be readily accessible to the customer upon request, or at appropriate times (like a tax time report). ‘V’ Pharmacy is also building robotic pill dispensing facilities to allow the pharmacist greater time advising and consulting directly with customers or on-line customers.

Relevant metrics on the service offering need to be collected and managed, such as cost, ROI, service rate, and the like. As the service offering in SVN may involve many connectivity modes and SC partners, dependability of the service becomes a key parameter to monitor and manage. From a supply chain perspective, a knowledge base of the supplier network in terms of performance metrics on quality, efficiency, effectiveness, and agility needs to be developed. In addition, web layout, linkages to SC partners, and response times need to be carefully designed and managed. From a demand chain management perspective, automation, internal assistance, and Customer Relationship Management (CRM) all play an important role as well.

V. Inputs Virtual Network and Service Performance

The network dimension of the embedded connectivity of SC partners through varying sales channels implies that delays, incorrect information, and/or security breaches can have a leveraged negative effect on the overall service experience. Alternatively, a synchronous delivery by all partners involved may create a unique competitive edge through elevated service offerings. The quality dimension of providing relevant and targeted information, dependability of the service offering by each SC partner, flexibility to incorporate new updates from suppliers (ie product information), agility to deploy new hardware/software applications, quick response time to information requests, ease of access, security with built-in privacy protection levels, are all factors that enable or impair service delivery in a SVN framework. Table 3 displays the dimensions of the virtual network and its service performance.

Examples of resulting service offerings typically applying to Table 4 may include:

- An on-line pharmacist via
 - a video phone or video conference or teleconference
 - a personal chat room
 - Email or SMS.
- An evaluation of medical and cost alternatives to a prescription
 - A ‘side-effects’ report

- A home deliver service.

- A doctor - pharmacy direct link so that your prescription could be ready when you arrive, or be home delivered.

A database list of localities of nearby doctors and their current available appointment times.

Table 3: Virtual Network and Service Performance

Virtual Network and Service Performance	
Dimension	Operational Characteristic
Cost	IT networking cost; Customer servicing cost
Quality	Internal information sorting; External customer product delivery
Dependability	Reliable business networks, Reliable customer services
Flexibility / Agility	Capability to change; Uniqueness capability
Response time	Ability to service customer
Personalization	Ability to individually target customer; Ability to individually respond to a customer
Convenience	Multiple customer access modes; Multiple customer response modes
Style fashion	Ability to deliver added value solutions
Ethics	Security and privacy of business information; Security and privacy of customer information
Technology	Strategically operationalize latest technologies

Table 4: Dimensions Influencing Elevated Service Delivery

Dimensions Influencing Elevated Service Delivery	
Dimension	Operational Characteristic
Cost	Access medical & cost alternatives evaluation report to a prescription
Quality	Analyse & identify new markets, customer options, business opportunities
Dependability	Offer a possible drug ‘side-effects’ report, &/or a home deliver service
Flexibility / Agility	Allow home deliver of prescriptions
Response time	Doctor → pharmacy direct link so customer prescriptions instantly prepared
Personalization	Link secured areas to each customer’s personal medical, hospital, ambulance, tax, insurance, banking, etc information & allow emergency in response to a car accident injury that required hospital intervention
Convenience	Provide access to on-line pharmacist by: all methods eg. video phone, video conference, teleconference, personal chat room, Email or SMS
Style fashion	Keep abreast of latest trends
Ethics	Continually learn from individual customers & use knowledge acquired to better assist customers to meet their PI/related areas preference needs
Technology	Allow direct computer access by local doctors, thereby guaranteeing prescription communication accuracy and delivery

Specific attributes/knowledge bases of a pharmaceutical SVN also applying to Table 4 may include:

- Linking of secured aspects of individual customer personal information to medical-, hospital-, ambulance-, tax-, insurance-, and banking information to enable a full emergency response service related to a car accident injury that required hospital intervention.
- allowing direct computer access by local doctors, thereby guaranteeing prescription communication

accuracy and delivery

- delivering personal prescription information (or a purchase), offering new knowledge to the customer about a purchase, and performing all levels of related interactions eg. pill recognition, reaction time, insurance ramifications, deals, best price, etc.

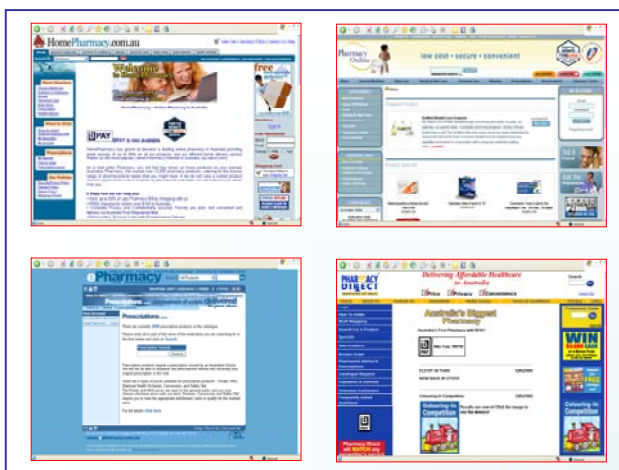
VI. Areas for Future Research

Thus far major dimensions of a generic service value network approach to e-pharmacy were identified. In Australia, on-going research is delivering the components of the pharmacy industry SVN. Future research would need to construct specific relationships among drivers, enablers, and outcomes of such a SVN-framework, and empirically test these for the pharmacy industry at large. Currently, the deployment of a full scale SVN methodology is definitely on the horizon, but still in its infancy.

VII. Conclusions

The concept of a Service Value Network for the pharmacy industry was discussed, along with the major underpinning dimensions. Such a SVN approach may eventually lead to better strategic alignment, higher industry performance (capabilities and delivery), greater value-adding solutions, increased customer satisfaction, and more competitive pricing. Within the Australian pharmaceutical industry, the emerging e-pharmacies are a partial response to industry restructuring and competitive positioning. This evolution was put in context of a SVN approach, and resulting elevated service offerings were described.

Appendix: Major E-Pharmacies Operating In Australia



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Do E-Business Investments Create Competitive Advantage: Perspectives from the Australian Banking and Financial Services Industry

Sally Rao Indrit Troshani
School of Commerce The University of Adelaide
233 North Terrace, Adelaide, SA 5005 Australia
Email: {indrit.troshani, sally.rao@adelaide.edu.au}

Abstract: Are advantages provided by e-business vanishing as IT becomes ubiquitous and affordable? Is it losing its strategic value and, therefore, its potential for strategic differentiation? This paper proposes a conceptual framework to assess strategic IT investments for e-business. The framework captures several business, human and time dimensions. It is argued that the interaction of these dimensions with IT is hard to be imitated by competitors, and has therefore, the potential to generate and sustain competitive advantage. We attempt to answer these questions by using the perspectives of IT practitioners in Australian financial service industry in the first of a multi-stage study.

Keywords: e-business, e-commerce, competitive advantage.

I. Introduction

The underlying technologies of e-business, such as computing technology, network communications, etc. are developing at exponential rates and becoming cheaper [6,27,29]. These technologies underlie basic e-business functions such as data storage, processing and transport. Currently, these functions are easily imitable and have become homogenised and “available and affordable to all” (Carr, 2003, p. 42). These are, therefore, becoming increasingly indistinguishable among different organisations. Because of the ‘vendorisation’ of hardware and software, universal technical standards are now forced onto users [6]. Hardware and software costs have decreased, and therefore, IT has become more susceptible to commoditisation, and is likely to become like rail transport, electricity or telephone service.

As e-business models are heavily reliant on IT, they may no longer provide firms with strategic differentiation. Many argue that investments in e-business are a competitive necessity rather than a source of competitive advantage. These views are also substantiated in recent e-commerce research with specific applications of IT, such as enterprise resource planning systems (ERP) [11,21,33]. For instance, Lengnick-Hall et al. (2004) argue that on their own, ERP systems are insufficient to provide sustainable competitive advantage. Also evidence suggests the average Fortune 200 organisations spend 20-40% of their budget on IT just to

stay competitive [26].

Even in the cases where e-business was found to enhance competitive position, the nature of the interaction between pre-existing business and human resources on the one hand, and e-business applications on the other, is poorly understood and has not been clearly specified [12,37,41,42]. Thus, the aim of this paper is to propose a conceptual framework which consists of factors that can generate and maintain competitive advantage through the quality interaction of e-business applications and other resources. This is expected to be the first step in addressing the gaps in the current literature. Preliminary findings of research carried out with firms operating in the Australian banking and financial services industry are also reported.

II. Key Concepts and Literature Review

The concept of competitive advantage has a long tradition in the strategic management literature. A fundamental goal for businesses is to develop a means by which they can perform better than their competitors. South (1981) defined it as “the philosophy of choosing only those competitive arenas where victories are clearly achievable” (p. 15). Much of the focus of recent research has been on identifying such sources of competitive advantage. For example, Porter (1985) argues that competitive advantages can be generated through a cost leadership, a differentiation advantage which will in turn lead to relatively higher performance. That is, productivity, performance and profitability are the antecedents of competitive advantage [31,40].

There are two mainstream schools of thought in theory development of IT-generated competitive advantage. The resource-based view essentially argues that firms allocate resources to acquire IT-related products because it is assumed that these investments provide economic returns to a firm. There are a number of resource typologies. For example, resources can be organisational, business and technological. Organisational performance depends on the integration of resources across these categories. Some of these resources interact with IT to produce sustainable advantages. Grant (1991) and Makadok (1991) emphasise that while resources by themselves can serve as the basic units of analysis, firms create competitive advantage by assembling these resources to create firm specific capabilities. These capabilities, embedded in organisational processes, provide economic returns because the firm is more effective than its competitors in deploying resources [14,23].

The second school of thought is represented by the

transaction cost theory which focuses attention on the exchange relations between buyers and sellers where the term transaction represents a transfer of goods 'across a technologically separable interface' (Williamson, 1985, p. 1). Firms make decisions in order to minimise their transaction costs by engaging in exchanges with other firms or individuals. Therefore, markets and hierarchies represent polar extremes on a continuum of exchange [24,44,45]. The choice an organisation can make between these two extremes depends on the outcome of the interaction between "human elements" and "environmental factors". Information technological developments allow organisations to be engaged in network behaviour to reduce transaction costs, increase coordination, thus efficiency. Electronic interconnection is both possible and desirable. For example, Malone, Yates and Benjamin (1987) argue that market coordination is enhanced through electronic communication, electronic brokerage and integration effects.

However, the transaction cost theory has limitations which have been highlighted in a growing number of empirical studies. Transaction costs and benefits associated with the exchange process have been recognised as difficult to isolate, particularly when the transactions involve more than two members. Transaction cost theory uses the competitive paradigm to refer to exchange participants as economic units. This is one of its major weaknesses as it ignores the long-term interactions within economic and social relationships [18]. Indeed, exchanges between firms have become increasingly characterised by non-market governance such as long-term associations, contractual relations and joint ownerships.

III. Developing a Theoretical Framework

Based on extant literature of the two schools of thought a theoretical framework can be proposed. This is important because the framework constitutes an attempt to reconcile aspects of different schools of thought into a single synthesis. The factors in the proposed framework are discussed next.

Alignment between e-business and Overall Business Strategies. E-business strategies should be consistent and well matched with the overall organisation business strategy, if they are going to provide competitive edge to organisations [17,19,32]. Consistency should also exist between business strategic planning and e-business planning [3]. However, consistency may be necessary but not sufficient. For instance, Powell and Dent-Micallef (1997) examine numerous sources which conclude that e-business and overall business strategy can become a symbiotic integration, and therefore, constitute a "potential advantage-producing complementarity" (p. 381). This alignment is likely to be difficult to replicate because both e-business and overall business strategies are likely to evolve uniquely for each organisation. E-business applications can support collaboration by bridging the traditionally socially complex gaps between functional departments. This, in turn, can enhance an organisation's competitive position and its ability to create strategic value in several ways, including productivity enhancement and service quality [22,25,30,32,42].

Inter-Organisational Linkages. Inter-organisational linkages refer to the organisation's ability to strategically use electronic linkages such as EDI and extranet to establish

upstream partnerships with suppliers and downstream relationships with customers [8]. Generally organisations are not internally self-sufficient; this requires resources from the environment. Therefore, organisations become interdependent with those elements of the environment with which they exchange resources. Organisational and ecological theorists argue that organisations develop internal and external strategies seeking to minimise the uncertainty arising from dependence on the environment for resources [15,16].

Using e-business applications to enable such linkages is likely to facilitate complex interactions and cultivate collaborative relationships. The nature of these interactions as well as the way these are used to handle environmental complexity are likely to be unique, and therefore, more likely to survive competitive imitation. From an e-business perspective, the value chain model highlights the interdependence between organisations along the value chain where competitive strategies can be best applied and e-business is likely to have strategic impact. Recent research, however, shows that trust is essential if partnerships and relationships are to be effective and enduring in generating competitive distinctiveness [38].

E-business Integration with Business Processes. Business processes can contribute to the overall business efficiency, and therefore, be a source of advantage. Increasingly, business processes are becoming standardised and embedded in e-business applications. As a consequence, these become replicable and subject to competitive imitation. However, innovations in the business processes and in the ways these are integrated with e-business are likely to be organisation-specific, and therefore, less likely to be easily replicable by competitors. It follows that e-business investments can have strategic effects when addressing sustained initiatives for innovating business processes [39]. Marchand et al. (2000) substantiates this idea with examples of banks that "have focused on getting e-business support for key processes in place to manage customer and product information for sales support, cross-selling, and customer service. From this base, they [19] have developed sophisticated systems and databases for management support, product innovation and business strategy formulation." (p. 75).

Organisational Agility. E-business can be a primary enabler in providing the necessary support for developing an organisational capability to be agile in adapting in an ever-changing environment [2]. This includes flexibility and responsiveness, which are necessary for organisations to respond quickly to the fluctuating customer needs and competitive landscapes. E-business applications can facilitate significant alterations to rigid traditional hierarchies. For example, the intranet can assist in the development of "shallow structures [which] may increase likelihood of success since they may improve communications, help achieve process orientation, and indicate less bureaucratic management." (Chaffey, 2004, p. 445).

Leadership style may also be easily changed from coercive or directive to consultative or collaborative [9], which in turn can result in effective and efficient team orientations [34]. E-business applications also facilitates, rapid project development and deployment and the capability to undertake strategic change [2]. However, in different

organisations, these alterations encounter varying degrees of managerial resistance, flexibility and inertia which are likely to result in different levels of organisational agility. These differences can constitute a source of distinctiveness among organisations.

Management Commitment and Support. Management commitment and support is important because it has the potential to differentiate successful from unsuccessful e-business investments. Research shows that lack of awareness and understanding of the potential benefits and value to be gained by e-business investments can be a significant barrier for successful strategic implementations [30]. Managers with negative orientations toward e-business are likely to exhibit negative attitudes, which adversely affect their commitment to strategic IT implementations, and subsequently, resource availability and deployment [1,25]. This suggests that lack of management support is likely to have little impact on competitive position. In contrast, strong management support is likely to affect organisation-level competitive advantage positively [42].

Interactions between IT Professionals and E-business Application Users. Organisational performance is increasingly affected by the nature of the interactions between IT professionals and end-users. When interactions are based upon rich and cooperative dialogue, end-users are more likely to enhance their understanding of the potential IT has to offer. Likewise, IT professionals are more likely to better understand the problems the end-users face [10]. Consequently, rich and quality interactions can be the source of innovative insights, which are vital for developing supporting applications, and are therefore, considered as a key success factor of e-business investments [36]. However, patterns of interactions between IT professionals and end-users are different in different organisations which suggest that innovative insights are likely to be unevenly distributed. This constitutes an opportunity for asymmetric distinctiveness across organisations, and therefore, the accomplishment of competitive advantage becomes possible.

Organisational Culture. Organisational culture is important as it affects the employees' orientation towards innovations in general [28,36]. It also creates a climate for either encouraging or discouraging risk taking and experimentation with e-business applications [3]. Boddy et al (2001) argue that there are different types of cultural orientations that can be identified in different organisations. Accordingly, culture is affected by several factors, including the environment, degree of formality, openness, consensus, team and collaborative orientation [25]. All these factors are

likely to create unique cultural profiles for different organisations [5,8]. Consequently, these profiles affect e-business decisions and use patterns in inimitable ways, therefore creating a potential for strategic differentiation among organisations.

Intellectual Resources. Intellectual resources include organisational human resources with technical and managerial IT skills. The relatively high mobility of IT employees suggests that some e-business skills may become accessible to competitors [20]. However, Bharadwaj (2000) and Wade & Hulland (2004) argue that due to their distinctive and tacit nature and organisation-specific interpersonal relationships which take years to be perfected, application development, technology integration skills, corporate-level knowledge assets and managerial human resources become difficult to acquire and highly complex to imitate by competitors. Therefore, these resources are likely to produce unique idiosyncratic casually ambiguous capabilities which serve as source of sustained competitive advantage [35,42].

In table 1 we summarise the factors discussed above into two major categories, namely, business and domain factors.

We argue that the factors themselves should be assessed both qualitatively and quantitatively in terms of the reactive nature of interactions among the factors and the extent to which competitive advantage is generated and sustained. Black & Boal (1994) suggest that the result of the interactions includes three types of relationships, namely, compensatory, enhancing, and suppressing. A compensatory interaction exists when a change in one factor is offset by a change in another factor. An enhancing interaction exists when the presence of one factor amplifies the effect of another factor. Suppressing interactions exist when the presence of one factor adversely affects the impact of another [4]. Further, the factors identified above can affect competitive position in different ways. For example, while organisational linkages may be relatively strong in creating competitive advantage, they may also be relatively weak in sustaining it because they may be easily imitated by competitors. Efforts have been made to assess the ability of e-business to generate and sustain competitive advantage. However, these are only hypothesised rather than proven [42]. In addition, the time dimension over which competitive advantage persists may depend on several factors, including but not limited to industry specific variables, product lifecycle, intellectual property copyrights and patents [43]. Therefore, the measurement of the contribution of time dimension requires special consideration as well.

Table 1 – Business and Human domain factors

Business Domain Factors	Human Domain Factors
<ul style="list-style-type: none"> - Alignment between IT and overall business strategies (ALIGN) - Inter-organisational linkages (LINK) - IT integration with business processes (PROCINTEG) - Organisational Agility (AGILITY) 	<ul style="list-style-type: none"> - Management commitment and support (MGT) - Interaction between IT professionals and end users (INTERACT) - Organisational culture (CULTURE) - Intellectual IT resources (INTELRES)

IV. Methodology and Results From Pilot Interviews

To explore the factors included in the proposed framework, the qualitative methodology of convergent interviewing was used. This choice of methodology was justified for its theory-building capability [7]. This research is exploratory because we need to gather insights into the phenomenon and to provide a better understanding of the issues involved. The convergent interviewing process involved conducting a series of in-depth interviews in which data was collected during each interview, analysed and used to refine the content of *subsequent* interviews. That is, the process was structured although the content of each interview remains unstructured or semi structured to allow for the flexible exploration of the subject matter without determining the answers [7,13]. This process identified important information on which further research may be based (Dick, 1990). The convergent interviews were undertaken with Chief Information Officers (CIOs) and IT managers of the companies in the Australian banking and financial services industry. These managers are key informants because they are closely involved in e-business planning and implementing process in their respective firms and had an understanding of the entire decision making process. A number of 9 interviews have been carried out so far. Participants were from a variety of financial service firms including investment and merchant banks, mortgage and savings banks, building societies, credit unions, and insurance. There are signs of convergence in terms of data patterns on most issues.

Overall, the findings from the convergent interviews provided evidence that e-business application do provide competitive advantages to varying degrees for different organizations, depending on how they have been integrated with the identified factors in the framework. However, e-business applications do not change the general nature of a business. For example, one interviewee commented: "the term e-business can be misleading...there is only business, not e-business...e-business applications are simply tools that a business can use to improve its performance." a

Although top management's support and commitment vary at times, most firms in the financial services industry are committed to e-business and have invested heavily into IT and e-business applications because e-business take-up is considered crucial in this industry. Nevertheless, several participants were consistent in indicating that investments in e-business solutions should be made if they add value to the business rather than to just "stay up to date". The impact of e-business investment on overall business performance vary amongst firms depending largely on the core value proposition and the overall business model. For example, for a startup online bank, success planning and implementation of e-business applications is considered vital as one of the participant stated, "it is a matter of surviving or dying...". Most of the participants took the periodical, systematic

review approach to updating e-business systems. However, IT practitioners generally experience difficulties in keeping up with e-business application developments. One way of doing that is through industry forums where they meet on a regular basis and discuss relevant issues. Although some of the participants encountered resistance from users in the organization in implementing new e-business applications, they generally overcome the resistance rather effectively through structured training programs and providing rationale for the new application well in advance.

There was a general consensus that e-business solutions should be customer-centric and service-oriented. Business process improvement was seen as the main driver of e-business investments. Further, in organizations where working legacy systems are still in use, e-business solutions were seen as a means towards their aggregation with the aim of improving business process automation and overall information accessibility. In addition, crucial determinants of the successful implementation and use of e-business systems were a fluid business culture and a continuous involvement of key stakeholders in the development of e-business solutions.

Generally, the preliminary findings described in this paper are consistent with the literature. However, after the research issues have been fine-tuned in stage one, stage two will test for statistical generation across the population of the organisations in the Australian financial services industry, using the methodology of a Web survey. Multiple regression will be used to analyse the survey data to examine the interdependencies of variables.

V. Conclusion

There is a general consensus that e-business has become pervasive and relatively easy to acquire in competitive markets. This, however, does not mean that e-business has lost its potential to provide competitive advantage. We argue that potential for distinctiveness exists in the way e-business applications interact with a selected, but non exhaustive list of business and human domain factors within specific time frames. Such interactions are unique and may result in organisation-specific capabilities which may be hard to duplicate. As such, unique interactions constitute a source of competitive advantage. Clearly more systematic empirical study and more detailed formal analyses are needed to confirm and measure these interactions and their resulting contribution to enhance organisational competitive position.

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The Critical Success Factors and Integrated Model for Implementing E-business in Taiwan's SMEs

Chen Te Fu *, Yi Chen Lan **

* PhD Candidate, School of management, University of western Sydney
Lecturer, Cheng Shiu University, Taiwan

Email: phd2004_05@yahoo.com

** Senior Lecturer, School of computing and IT, University of western Sydney
Email: y.lan@uws.edu.au

Abstract: **Purpose** - To date, identifying barriers and critical success factors (CSFs) and integrating business model in implementing e-business for SMEs have not been systematically investigated. Few existing studies have derived their CSFs and business model from large companies' perspectives and have not considered the needs of integration for smaller businesses. This paper is aimed to bridge this gap. **Design/methodology/approach** - Existing studies on CSFs and e-business model were reviewed and their limitations were identified. By integrating insights drawn from these studies as well as adding some new factors, the author proposed a set of 18 CSFs which is believed to be more useful for SMEs. The importance of the proposed CSFs was theoretically discussed and justified. In addition, a case study was conducted to evaluate the extent of success of this proposition. **Findings** - The overall results from the case study assessment were positive, thus reflecting the appropriateness of the proposed CSFs and integrated model. **Practical implications** - The set of CSFs and integrated model can act as a list of items and an easy to follow model for SMEs to address when adopting e-business. This helps to ensure that the essential issues and factors are covered during implementation. For academics, it provides a common language for them to discuss and study the factors crucial for the success of e-business in SMEs. **Originality/value** - This study is probably the first to provide an integrative perspective of CSFs and integrated model for implementing e-business in the SME sector. It gives valuable information, which hopefully will help this business sector to accomplish e-business visions.

Keywords: e-business, e-transition, CSFs, SMEs, e-commerce.

I. Introduction

Indisputably implementing and maintaining e-business for those large organizations is just another routine operation for their IT departments to ensure the business activities are performing efficiently. Nevertheless, small and medium-sized enterprises (SMEs) have far less resources and budgets to invest in IT enabled operations or the e-business vision.

According to the figure reported by the IDC Taiwan in

2003, there are 1,060,000 SMEs in Taiwan and just fewer than 40% of them have involved in e-business activities (having financial transactions through the Internet). This signifies that at least 636,000 SMEs have not engaged in e-business operations. However it does not mean that these SMEs have not considered the implementation of e-business operations. Most SMEs have recognised the need to change their current business processes to achieve the capability to engage in web based e-business activities. However, lacks of resources and budgets have prevented them from pursuing or continuing the e-business activities.

The key question this study tries to answer is what is the real factor that affects in implementing e-business operations in SMEs? This paper starts with surveying the e-business literature and identifying possible hurdles of transforming SMEs into e-capable (electronic capable) business operations. It is followed by categorising those factors or hurdles into two recognition phases. In addition to the hurdles, numbers of CSFs for SMEs to conduct e-business operations are identified and discussed. Through the literature study and investigation of various e-business transformation models, the authors have identified the components required for SMEs to transform into e-business operations successfully. A case study was introduced to verify the hurdles as well as the CSFs. This paper concludes with the proposition of an integrated e-business model to amalgamate all required components and provide e-business implement steps for SMEs.

II. Literature Review

The use of the Internet does not automatically mean placing a barrier between the firm and its customers and/or its suppliers. Revolve around inter-firm relationships. Many firms have invested in these relationships, sometimes over generations, and these relationships are key assets of the firm. The challenge is to leverage off these assets to a new level of competitiveness not to undermine them.

O'Keeffe (2001) outlines what the Internet can or cannot do by exposing seven myths. These are presented in Table 2-1, the myths and realities of e-commerce and discussed below.

Table 2-1: The myths and realities of e-commerce (O'Keeffe, 2001)

The myths	The realities
1. The Internet destroys relationships	Manage relationships as intangible assets
2. The Internet disintermediates	Value is more transparent
3. Simply reduce transaction costs	Focus on process costs
4. The Internet is about public information	Private information flows can be enhanced
5. A single hardware purchase	A dynamic relationship with a solutions provider
6. High risk and high investment costs	Amortised costs and low risk trial adoption
7. The Internet levels the playing field	The Internet leverages investments in reputation and relationship assets

The Internet is not about dis-intermediation but companies who do not add value or who have not invested in relationship or reputation assets are certainly under threat by the Internet infrastructure. The Internet infrastructure allows firms to manage the boundaries within the firm and between the firm and other players in the network to a new level of effectiveness and efficiency.

The e-commerce platform is not simply about adoption with current inefficiencies, but about re-engineering the total system. There are further opportunity savings as buyers and sellers can develop new accounts and invest in developing new relationships and strengthening current relationships. It is all about relationships as assets.

Hence, it is clear that the Internet is not about levelling the playing field, quite oppositely the Internet poses a competitive threat to those companies have lack of strategies or those with poor reputation or relationship assets. The Internet does provide the infrastructure for firms to unleash the power of past investments in their relationship and reputation assets and to develop these assets even further for long-term competitive advantage. The Internet provides a breakthrough technology in managing the boundaries of the firm both within the firm and with other firms in the network (O'Keeffe, 2001).

The literature in e-business strategy has addressed a wide spectrum of issues with regard to transforming an organization into e-business operations. (Mirchandani & Motwani, 2001; Davy, 1998; Alexander, 1999). Furthermore, researchers have also discussed e-business adoption in various industries (Korchak & Rodman, 2001), regions (Beveren & Thomson, 2002; Gani, 2002; Walczuch et. al., 2000), and detailed technical steps involved in the transformation process (Eduard, 2001).

When analysing SMEs in e-business adoption, we have identified various factors that prevent them from using the full potential of the World Wide Web. The first contribution of this study is to identify the hurdles that affect the adoption of e-business operation in both pre- and post recognition phases. Furthermore, the second contribution of this study is

to propose a set of critical successful factors for SMEs and an integrated model through a case study. The following sections outline the discussion of each factor within the associated phases and illustrate the development of e-business model.

According to Clayton (2000) more than 60% of the small companies do not have a plan for their business strategy. Although the remaining companies have such plans, there is no indication that e-business operation strategy has been incorporated. Lack of such incorporation or recognition of e-transition strategy in business plans is considered as the major barrier in the success of e-business establishment. In the case studies conducted by the NOIE (National Office for the Information Economy) and Earnest and Young (2001), they have identified a number of factors that prevent SMEs moving to online operations, which are outlined as follows:

- Difficulties in finding reliable information that supports the e-business establishment;
- Difficulties in finding appropriate resources for a successful implementation;
- Difficulties of getting cost effective rates from ISP's (Internet Service Providers);
- Higher costs of payment gateways for online transactions; and
- Difficulties of finding and arranging suitable logistic solutions for product deliveries.

However, these factors merely represent the impediments in a single domain, which falls under post-recognition of e-transition strategy, and have no hurdles been discussed prior to the recognition. Hence, the factors need to be further categorised into two domains, namely "pre-recognition" and "post-recognition".

II. 1 Factors Affecting Success

The e-transition recognition model introduced in Figure 2-1 brings all the hurdles in the pre-recognition and the post-recognition phases into a big picture. The proposed model is to be applied by SMEs to identify the bottlenecks and develop an appropriate practical plan, which will lead them to the success in e-transformation vision. The following sections explain the components of e-transition recognition model including recognition stage itself and pre- and post-recognition phases.

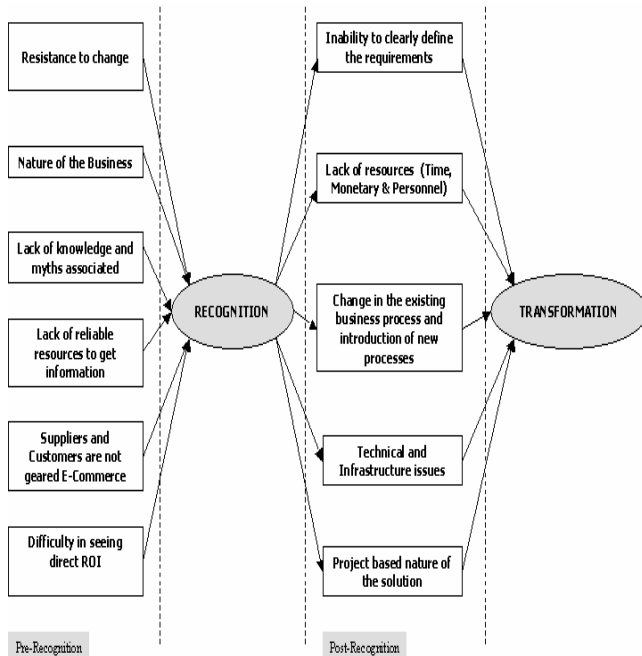
II.1.1 Pre-Recognition Phase

Based on our experience in working with SMEs in Taiwan in the e-transformation activities, we have identified the six factors in pre-recognition phase. In most situations these factors tend to strengthen each other making it further difficult for a small company to find solutions to the e-transformation puzzle.

1. Resistance to change.
2. Nature of the business.
3. Lack of reliable resources to get the correct information.

4. Lack of knowledge and myths associated with it.
5. Suppliers and customers are not geared e-commerce.
6. Difficulty in seeing direct ROI.

There has been some effort made to set up a mechanism to calculate the ROI of e-business initiatives (Edurad, 2001), but there is no one single formulae that can be easily applied to suite every SME.



The factors in the Pre-Recognition phase converges into the biggest barrier the “Recognition” and after the recognition it diverges into the factors in the Post-Recognition phase. In the case of a particular Micro Company it could be one or a combination of factors in both phases that might affect its E Transformation.

In the following section we will discuss these factors in detail with few real life examples.

Figure 2-1. E-transition recognition model

II. 1. 2 Post-Recognition Phase

After successfully passing all the hurdles discussed above, SMEs would have recognized the need of e-transformation in order to be ahead in the competition. At this point they might have preliminary plans to carry out the transformation tasks.

We have identified five hurdles that might prevent a SME actually implementing the e-business operations. As in the pre-recognition phase, factors in the post-recognition phase also have impacts on each other, which strengthens its affect and prevent the e-transformation becoming a reality.

1. Inability to clearly define the requirements.

It is unclear as to what it means to the business community and even to the most of the web community. None of

the above is considered as truly e-transformed organizations. Only when the internal information systems are fully converged with the external/online information systems the e-transformation is achieved (Khandelwal et. al, 2004).

2. Lack of resources.

These resources are time, funds and personnel.

3. Change in the existing business process and introduction of new processes.

In case of a site where the customers can place on-line orders it would be important to have new business processes to handle orders and proper logistics to deliver goods. Inability to handle these changes or allocating resources to handle these new processes would result a failure in e-transformation.

4. Technical and Infrastructure problems.

SMEs operate in remote areas where the IT and telecommunication infrastructures are not available for getting access to the Internet or services from ISPs.

5. Project based nature of transformation and maintenance.

Most SMEs without in-house IT staff would need to outsource the development of e-business operations. Generally these types of activities are carried out in a project-based format where the project ends with the handing over.

II. 2 Factors Achieving Success

Identifying the CSFs (critical success factors) allows a firm to realize the full advantages of achieving e-business solutions. We have highlighted six CSFs based on the literature and our experience as follows.

- The first CSF is to identify a suitable vision for the firm. This vision is important as it provides everyone in the organization with the future direction.
- The second CSF is that the firm must also have an e-business champion who will help make the vision a reality. This person must be a strong leader who owns the e-transformation process at a company, and must also be visual, energetic, and passionate about the transformation.
- The third CSF is the creation of a healthy company culture. With this energized corporate structure, all employees will be involved in the corporate decision-making process.
- The fourth CSF is the development of a plan to achieve the e-transformation (Marzulli, 2000). This plan needs to be in document form and include milestones and metrics that describe the e-transformation journey. The e-business champion and senior management should review this plan regularly.
- The fifth CSF deals with corporate communication (Marzulli, 2000). A rigorous communication strategy must

be implemented within the firm. This allows the organization to receive more feedback from constituents. This is imperative when e-business solutions are complex.

- The sixth CSF for an e-business firm is its ability to create flexible e-business solutions. This will allow the firm to grow in the future as well as personalize to various suppliers and customers.

If an organization can observe all of the above critical success factors, the expected e-business solutions can be achieved.

Furthermore, KITE identified nine CSFs relevant to the competitive performance of small businesses entering the e-commerce market. This list took as its starting point a number of CSFs that were suggested to us by one of the reviewers (van Rijsbergen, 1998). The original list was expanded and refined in the light of experience with the Web Corporation in KITE. A further two factors (commitment and partnership) were derived from the interviews with the best practice sample. The final list of 11 factors is shown in Table 2-2.

Table 2-2: Critical success factors (Jeffcoate, Chappell, and Feindt, 2002)

CSF	Description
Content	The effective presentation of a product or service offered over the Internet
Convenience	The usability of the Web site for the purpose for which it was designed
Control	The extent to which organizations have defined processes that they can manage
Interaction	The means of relationship building with individual customers
Community	The means of relationship building with groups of like-minded individuals or organizations
Price sensitivity	The sensitivity of a product or service to price competition on the Internet
Brand image	The ability to build up a brand name for the e-commerce business, and its products and services
Commitment	A strong motivation for using the Internet and the will to innovate
Partnership	The extent to which an e-commerce venture uses partnerships (value chain relationships) to leverage Internet presence and expand its business
Process improvement	The extent to which companies can change and automate business processes
Integration	The provision of links between underlying IT systems in support of partnership and process improvement

By eliminating repetitions, a core group of recommended actions for each CSF was derived. These were grouped by category so that Web Corporation could focus on the recommendations applicable to them.

II. 2. 2 The New Stage by Stage of CSFs

By integrating the abovementioned factors, the authors propose a more comprehensive model of 15 factors and separate into three stages for implementing e-business in SMEs (see Table 2-3).

Table 2-3: A set of new stage by stage of CSFs

Stage	CSFs
Start-up phase	Vision, company culture, a plan to achieve the e-transformation, commitment, content, price sensitivity and convenience
Growth/transition phase	e-business champion (leaderships), Corporate communication, control, interaction, community and brand image
Maturity phase	Ability to create flexible e-business solutions, partnership, process improvement and integration, strategic positioning in KVC, mobilization

In order to achieve the success in e-business transition the above CSFs could be segmented into three stages. Once an e-business has determined its strategy and stage of development, it can identify the CSFs that are applicable to it.

It is necessary through "stage by stage" to build an optimal model in implementing e-business. When SMEs develop their e-business model because they are lacked of resources, personnel and monetary. Besides, an optimal business model could help firms to form sustainable competitive advantage because unique business model is hard to be imitated by competitors. Therefore, referring above CSFs, the study further reviews a stage model which can describe the logical evolution of e-commerce involving different stages of development, each stage being better in some sense than the previous stage, can be useful in providing a roadmap for improvement to companies. A stage model, we believe, can do this.

II. 2. 2 A Stage Model for E-commerce Development

To achieve the goal of becoming an "e-SME", the Local Futures Group (2001, cited in Dixon *et al.*, 2002) suggest that firms must cross two digital divides:

1. The first divide involves acquiring basic ICT skills and technology to operate e-mail and simple brochure Web sites.
2. The second digital divide is the threshold to e-business proper, and requires advanced technology and IT skills (including R&D) and a wide range of specialist business skills and knowledge in areas such as management, strategy

and marketing.

It implies that all SMEs have the need and opportunity to follow one prescribed course; with the implication that not to finish the course (cross the divides) is some kind of

failure.

Furthermore, Subba and Glenn (2003) proposed that e-commerce development takes place in four stages (see Figure 2-2):

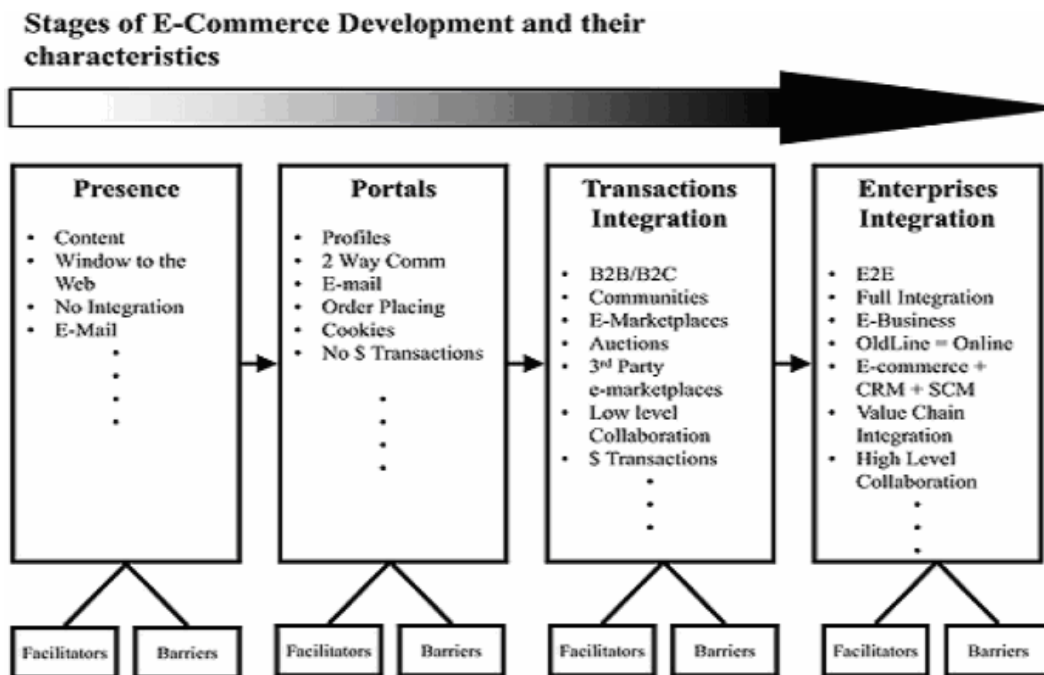


Figure 2-2: A stage model for e-commerce development (Subba and Glenn, 2003)

The four stages are listed below:

- (1) Presence (no integration).
- (2) Portals (no \$ transaction).
- (3) Transactions integration (low level collaboration).
- (4) Enterprises integration (value chain integration and high level collaboration).

The study argued that SMEs could start in any stage of abovementioned, it depends on their resource, personnel, technological support, and so on. The model allows for a company to enter at any stage. It is not necessary that a company begins at the presence stage and then progresses through subsequent stages although the stage model as proposed appears sequential. It depends on the degree of increasing awareness for technology and e-commerce. The point is what factors promote and what factors inhibit or retard e-commerce development and implementation at a particular stage. S. Subba, Glenn, Carlo A., (2003) call these facilitators and barriers to e-commerce development and implementation. If the primary impact of the factor is internal and within the control of the SME, they classify it as a facilitator since the enterprise can improve its readiness for a given stage. On the other hand, if the primary impact of the factor is beyond the control of the enterprise they have generally classified them as barriers.

II. 2. 3 Information Value Chain

In e-commerce operations, information is not viewed as a by-product of the strategic activities performed around the physical value chain. It is viewed rather to play a strategic role in itself. For this reason, strategic activities in the virtual value chain are performed in conjunction with information. This is well explained by Rayport and Sviokla (1995), with the concept of a "virtual value chain".

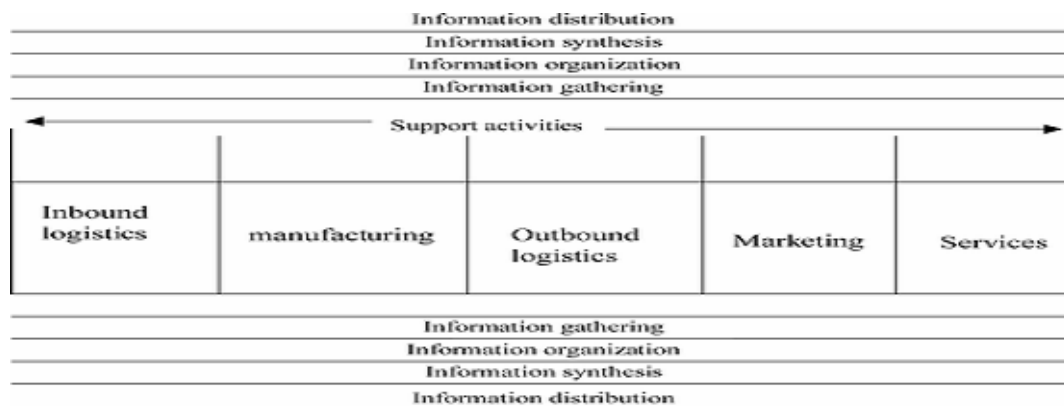
According to Rayport and Sviokla, a virtual value chain consists of "gathering, organizing, selecting, synthesizing, and distributing of information". Hence, it becomes imperative that businesses amalgamate virtual chain activities with physical activities to become fully integrated business operations to offer customized products and services, as shown in Figure 2-4. While virtual value chain enables companies to access information and finalise transactions, physical value chain ensures the order fulfilment and delivery of products and services to the customers (Rayport and Sviokla, 1995).

To be brief, the success e-commerce operations will depend upon the ways the physical value chain and the virtual value chain activities are matched and integrated into an information value chain.

It is obvious that merely integrating virtual value chain with physical value chain does not guarantee organizations in sustaining the competitive challenges. To take one step further, the optimal approach is for an organization to create its knowledge assets as knowledge turns into the main

source of competitive advantage (Miles, 1993; Miles *et al.*, 1994). The following section reviews knowledge value chain

and proposes the convergence of information and knowledge value chains.



Source: Adapted from Porter (1985) and Rayport and Sviokla (1995)

Figure 2-4: Integrated framework of virtual chain activities with physical activities (Rayport and Sviokla, 1995)

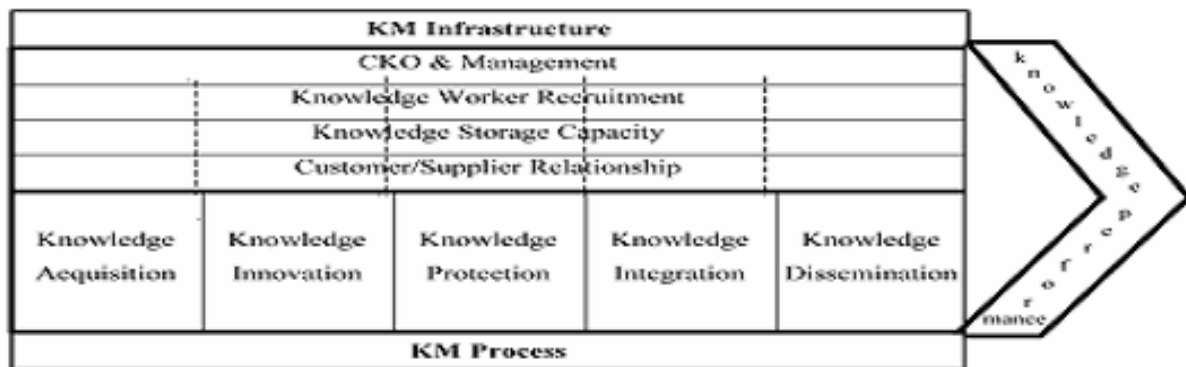


Figure 2-5: Knowledge value chain mode (Lee and Yang, 2000)

II. 2. 4 Knowledge Value Chain

Employing Porter's value chain analysis approach (Porter, 1985), Lee and Yang (2000) proposed a knowledge value chain model (figure 2-5).

These infrastructure components and activities are the building blocks by which a corporation creates a product or provides service valuable to its customers.

II. 2. 5 The Integration of KVC and Business Value Chain

As the value chain itself implies, each element of activity can create value and then all the value flows to the endpoint of the business value chain and joins together, forming the overall value of business, which is usually expressed as a margin (see Figure 2-6).

According this model, Lee and Yang (2000) proposed that the added value comes from the competence of element activity itself, which in turn comes from specific sub-KVC of itself, sub-KVC in inbound logistics (IL) operations (OP),

outbound logistics (OL), marketing and sales (MS), and service (SE) activity enables business to gain the competence, and then the added value follows. Finally, all the sub-KVCs are integrated together into the whole KVC. In the process of knowledge integration, the competence of knowledge infrastructure is gradually forming. In the end, corporation competence follows KVC. By analyzing the above, Lee and Yang (2000) note that competence is after all the measurement of each sub-KVC. KM is a process that transforms information into knowledge, it is suggested that competitive advantage grows out of the way corporations organize and perform discrete activities in the knowledge value chain, which should be measured by the core competence of the corporation.

The characteristics of the enterprises integration stage include all e-commerce and non e-commerce aspects of the enterprise. At this stage they become melted together to a single system that serves all the needs of the enterprise.

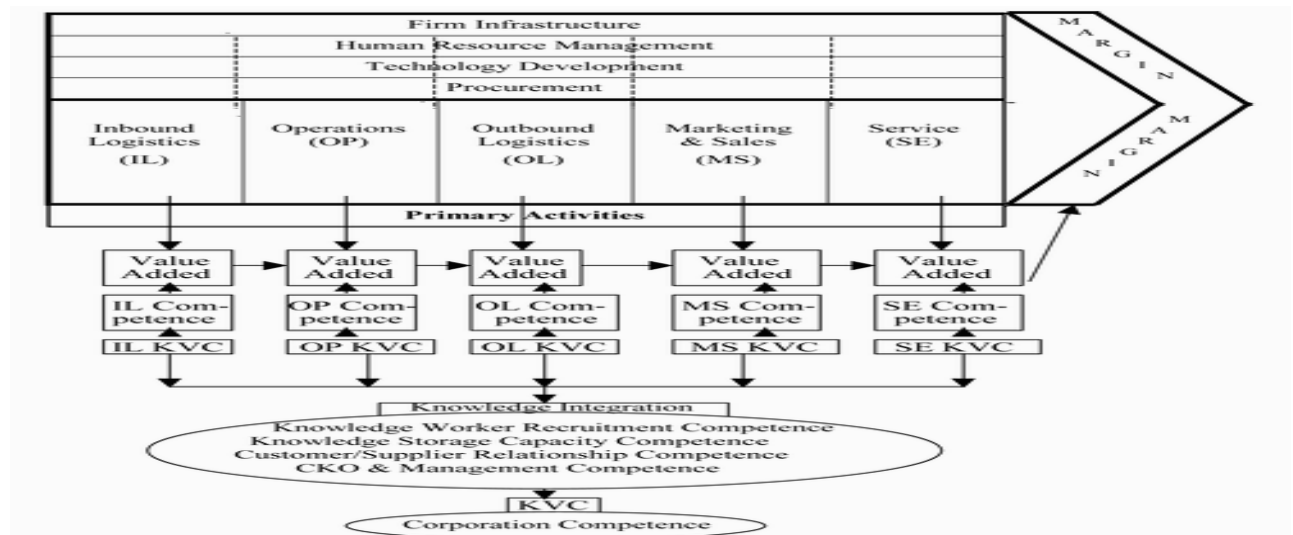


Figure 2-6: Relationship between business value chain and KVC
Source: Lee and Yang (2000)

II. 2. 6 EAI (Enterprises Application Integration)

Successful players in the EAI stage will be able to distinguish themselves if they:

- Intimately understand their partners' current and future/strategic needs.
- Work proactively with their partners to create solutions that address these needs.
- Use information sharing; and
- Have long-term contracts (Lacerra *et al.*, 1999; Krause *et al.*, 1998).

It is argued that significant opportunities for improvement often lie at the interfaces between the various supply chain member organizations (Handfield and Nichols, 1999). Whether an order is initiated by a Web-based customer or a mail order customer does not matter. At this EAI stage the e-commerce departments disappear and all business processes are fully integrated across internal systems and external participants (suppliers, business partners, and customers).

II. 2. 7 K-Business

While e-business gives us new access, exchange, and sales opportunities relative to information, k-business turns knowledge assets within a system into products, services, and profits. For e-business moves up to k-business, David Skyrme (2001) proposed ten Ps offer tips on online marketing that emphasize positioning, packaging, portals, pathways, pages, personalization, progression, payments, processes, and performance.

II. 2. 8 M-Business

A few years thereafter, Microsoft amended its statement to "empower people through great software, anytime, any place on any device." Being digital is out, being mobile is in. On November 21, 2002, when *The Economist* released its story

on "Computing's new shape," the cover page featured a Nokia phone, not a Microsoft pocket PC. In *The Freedom Economy*, Peter G.W. Keen and Ron Mackintosh portray the "mCommerce edge in the Era of the Wireless Internet." Just as personal computers and the Internet have changed the landscape of ecommerce, the authors argue, mCommerce will continue to extend the way organizations conduct business, while changing the relationships between companies, customers, suppliers, and partners. To them, mobility means freedom, which creates choice and, thereby, value. The key areas for expanding value through mCommerce are customer relationships, logistics, and knowledge mobilization, or intellectual capital.

In *Beyond Mobile*, a trio of Kairos Futures' consultants (Mats Lindgren, Jörgen Jedbratt, and Erika Svensson) take the mobilization of many businesses and organizations as a given. They focus on the human aspects of mobile technology, exploring the ways that people will work and communicate in the mobile marketplace. Their bold future scenarios extend to the year 2007. According to Ravi Kalakota and Marcia Robinson, the mobile Internet is transforming employee, supply chain, and customer interaction, and providing new innovation, cost-reduction, and revenue opportunities. Their *M-Business* shows how to reposition and develop business processes and enterprise applications to take full advantage of the mobile business wave that is portrayed as compelling and complex, even if its value is needlessly inflated ("and overtaking your organization even as you read these words"). The gurus of IT-driven e-commerce business guides explore wireless revolution from a business perspective. They introduce strategies that can be exploited to adapt from tethered, PC-centric models to mobile, person-centric techniques and strategies. Claiming to focus on the bottom line, the authors explain how senior and financial managers can plan for and differentiate m-business investments.

II. 3 Research Propositions

The aim of above review was to generate a series of exploratory research propositions relating to the barriers and CSFs for SMEs develop e-business activities while to embrace the technology and technique. The propositions generated follow, and a fuller explanation will be obtained through following case study.

- P1. The first stage of E-business start-up is to identify barrier to critical successful factors for transforming to e-business.
- P2. After transform successfully, the second stage is to integrate virtual and physical value chain to form an information value chain for unleashing the power of information and relationship assets.
- P3. The third stage is to integrate information and knowledge value chain, each element of activity can create value and then all the value flows to the endpoint of the business value chain and joins together, forming the overall value of business, competitive advantage grows out of the way corporations organize and perform discrete activities in the knowledge value chain.
- P4. The fifth stage is to integrate information and knowledge value chain to k-business to create knowledge assets.
- P5. The sixth stage is through EAI to integrate all systems to achieve sustainable competitive advantage.

III. Methodology

This paper adopts a case study to assess actual barriers and CSFs to the decision to implement an e-business strategy in the context of this particular SME. The completed questionnaire, company reports/industry-specific newsletters and a depth interview created an established chain of evidence.

Based on "grounded theory" the task of the researcher is to appreciate the different constructions and meanings that people place upon their experiences, rather than searching for external causes and fundamental laws to explain their behaviour. As Jones (1987) comments, grounded theory works because:

Rather than forcing data within logico-deductively derived assumptions and categories, research should be used to generate grounded theory that "fits" and "works" because it is derived from the concepts and categories used by social actors themselves to interpret and organise their worlds.

In SMEs most business decision-making is made by the owner-manager, therefore this person became the subject of an in-depth interview. The depth interview used the unstructured "tell me about it" approach to facilitate an open, flexible, illuminating way to study the complex, dynamic interactive situations such as management e-business decision making, providing:

The opportunity for the researcher to probe deeply to uncover new clues, open up new dimensions of a problem and to secure vivid accurate accounts that are based on

"personal experience" (Burgess, 1982; Easterby-Smith *et al.*, 1995).

IV. The Case Study

The subject of the case study was a private firm operating in the IT industry sector in Taiwan since 1987. During the ensuing period it has steadily established itself as a specialist provider of a comprehensive IC design service, the supply and fitting of new and replacement layout products of computer motherboard, which include various interface cards. From this perspective, the nature of the service is highly tangible, highly customised and is available on a knowledge-based basis by skilled people.

It is a simply structured organization with 12 direct employees carrying out all responsibilities for day-to-day operations and resting with the managing director. Although locally focused, the company's main objective over the next five years was to expand the business operations in the global markets. Their customers include computer motherboard industries, which generates approximately 80 per cent of their business, and their customers almost implement business to business (80 per cent) and business to consumer (20 per cent) operations.

Internal "e" enablers

Fitting into the theme of "awareness" and potential opportunities, from the completed questionnaire the authors were able to deduce that the owner agrees that having electronic mail and a Web site is important for the business. Furthermore the owner perceived that e-commerce will become increasingly important to the company in the future. "Access" to Web-based communications is supported by an ADSL broadband connection to the Internet. The company has taken the initial step to establish its web "presence" and having their "virtual door" opened in September 1995.

Internet commerce usage

In relation to "actual" usage the owner/ managing director explains that:

"I am not concerned about cutting costs and it was not my intention to operate the business purely in the Internet platform, and it was just another way to advertise my service offering."

The owner did not perceive that having a Web site could lower costs for the business, but did in fact view his e-business decision as an added expense in the short term. The primary e-business objective is to promote the organization's name and intent, and provide potential customers with information on the service/product offering. In relation to e-business operations, the company was unsure of how much business was initiated by e-mail or its Web site. However, with an extremely low-level (basic) Web site it may be suggested that there may be limited e-business success. It is a static one-page information-based Web site (page) that gives the visitor details of company location, introduction of products and services and a brief history (five lines) about

the company. There is, however, a contact facility (an online form) to enable contact with the company. At the time of the interview the owner had no plans to improve the sophistication/functionality of the Web site.

The "real" barriers

The dynamic environment that is synonymous with e-business is a similar environment in which this company operates where complex micro issues prevent further development in e-business. It becomes evident that the e-business processes of this small business are at present isolated from the strategic e-business context where the ability to implement full-blown e-business is for this company impeded by various obstacles. Each day the owner is more preoccupied with "fire-fighting to realize and fulfil customer orders, where there is a heavy reliance on face-to-face contact". The owner also perceives a lack of the suitability of Internet commerce for business purposes:

"Our service offering is highly tangible and is not really suited to the e-business environment."

This comment would support the e-services literature where the potential for electronic selling of services/products on the Internet is positively correlated with intangibility. (Lovelock *et al.*, 1999; De-Kare Silver, 2000). The "real" issues of limited resources were cited as inhibiting e-business activities where the owner stated:

"We do not have the resources (manpower and financial), or technical capabilities to manage the demands that online orders may generate ... there is also the issue of distribution."

The owner admits that he is not technically adept and the person responsible for all the administrative duties already had a huge workload to handle each day. Consequently, although this SME has taken an initial step towards e-business, the barriers to full-blown implementation relate to:

- Lack of senior management support/enthusiasm;
- Lack of skills among the employees;
- Lack of resources; and
- A lack of awareness of the benefits of e-commerce for the business.

Furthermore the high level of tangibility of the service/product mix is viewed as one of the major impediments to future utilization of Internet commerce by this particular small business. The "ideal" factors identified by Daniel and Myers (2001) as most important for e-business adoption (senior management support, a staged implementation and a clear understanding of the benefits) are missing from the strategic "e" context of this particular SME.

To date there has been no indication of advancement through the stages of e-business growth to maturity. Subsequently, it is suggested that the e-business decision was a natural reaction (as opposed to being proactive) to much of the hype that has surrounded Internet commerce adoption, rather than any pre-conceived ideas about the benefits for the business, where this particular small

business has taken a less than risky approach in their e-business decision.

To reiterate the aforementioned observation made by PricewaterhouseCoopers (1999):

"Often SMEs equate having a Web site with electronic commerce. They set it up and it sits there as a reminder of their failure."

The inherent lack of strategic emphasis in the e-business strategy of this small business makes this comment extremely pertinent. Perhaps justified by the fact that being at the experimental/informational stage of its development, the e-business objectives of this particular firm are being fulfilled, using the medium purely as a promotional tool. Consequently they have become a "virtual" statistic ... (whether skewed or not), viewed "as something justified by a univocal, irresistible 'progress'" (Winner, 1995).

E-business implementation steps

Before implementing an e-business solution, a firm must first identify its capability of handling an e-business solution. In relation to e-business implementing steps the owner indicated five major concerns on preparing e-business, they are:

1. Does every employee can use email to communicate with colleagues and customers?
2. Can the website achieve advertisement effects to promote the company's name and intent?
3. Can the website provide electronic transaction information for customers and suppliers and recommend potential customers with information on the service/product offering?
4. Do the firm and its suppliers use universal identifiers, codes and definitions to identify products and procedures within its electronic documents?
5. Does the firm link virtual and physical value chain to leverage the power of information and relationships assets?

Answers of most of these questions are positive, and the firm is ready for e-business implementation.

V. An Integrated SME-Business Model

Through above literature review and case study discussions, the authors proposed an integrated SME-business model to be an easy to follow framework for SMEs pursuing e-business operations as Figure 5-1.

Firstly, the study through e-transition model (e-transformation) to overcome barriers and achieve critical successful factors in e-business and therefore to the integration of the physical and the virtual value chain (create channel relationships and relationships assets). Secondly, to further integrate with knowledge value chain (create knowledge assets) to achieve k-business (knowledge business) (David Skyrme, 2001). Through k-business, SMEs can integrate internal and external information and knowledge sources to create value.

Moreover, the model through e-CRM to link with customer (create customer relationships assets) and through e-supply chain to link with suppliers (create supplier relationships assets). Finally, use EAI (Enterprises Application Integration) to integrate all of information and knowledge systems. EAI refers to the complete integration of business processes to the extent that old-line business is indistinguishable from online business (Subba and Glenn, 2003).

This level of integration involves high levels of collaboration between customers and suppliers. Enterprises integration includes full integration of B2B and B2C business including value chain integration. This level of integration utilizes the e-commerce systems to manage customer relationships (CRM) and the supply chain (SCM). This level of integration is e-commerce+CRM+SCM. This stage is somewhat of an ideal concept for the "e-world" environment. Many of the requirements of this stage still have technology problems and over-whelming integration issues for SMEs.

In summary, the study through case study and literature support, proposed two more items: strategic positioning in KVC and mobilization/communication to transform e-business to SMe-business (Strategic k-business + m-business + e-business) for smaller and medium-sized enterprises. This model can help firms to create value, relationship, information and knowledge assets, integrate internal and external resources and to achieve competitive advantage in the future development of e-business.

E-business implementation steps

It is necessary for an organization to carry out its own processes toward e-business solutions. A number of organizations have named a chief e-business officer to help coordinate e-business initiatives. This setting allows for centralized control of e-business across an organization, thus resulting in a greater efficiency. Companies must be cautious when they start e-business initiatives; this attitude would help firms quickly move to real-time processes (Karpinski, 1999). However, the speed of implementing these strategies has inspired strategic working alliances across a broad range of industries. This has been demonstrated through the alliances that have occurred between infrastructure organizations and Web boutiques.

Firms implementing e-business solutions should recognize the challenges that face their organizations. First, they should comprehend the dot-com advantage. This occurs as a result of clients/customers' preference for dealing with what they know and trust. This situation is often called the click-and-mortar integration; it occurs not only to the customers, but also to the suppliers. Another challenge is about catching the marketplace rules. That is, the Web will support the supply chain more than ever. The third challenge is that customers should be dealt with first. A quality e-business solution, while being electronic and integrative, should improve connectivity, knowledge management, and performance. It thus improves the efficiency of the firms.

The study identified seven steps to implement a successful e-business solution. Specifically, they are:

1. Set a vision: start from top-down. The executives in the organization must embrace the e-business initiative. A company must recognize that the e-business functionality is a business project instead of a technical task.
2. Recognize up to date: The firm must ignore all of its old ideas and rules on how business is operated and develop total new ways to conduct business. Especially what are their barriers and CSFs to implement e-business.
3. Know your markets: The firm's brand identity, customers, competition, and supply chain should be analyzed in the "know your market" phase.
4. Link: The firm must link virtual and physical value chain to form an information value chain, this way can leveraging the power of information and relationships assets.
5. Positioning: Strategic positioning what role the company in e-business and knowledge value chain will act.
6. Integrate: The firm must through EAI to integrate all various corporate systems then "create" its e-business solutions.
7. Evaluate and update anytime: The firm must modify its e-business solution anytime as speed and innovation are the keys to the e-business world.

VI. Conclusion and Future Research

Conclusions

The establishment of e-business operations presents tremendous challenges for maintenance in SMEs. The first stage of this paper is to identify barriers/factors through developing an e-transition recognition model and to find out critical successful factors through analysis of literature review. Secondly, summarize literatures review to construct a conceptual model and proposed some propositions. Finally, through case study to develop a new integrated model which can be employed by SMEs as the roadmap in their electronic business implementing process for transforming into digital business successfully and concludes with implement steps in e-business for practitioners and future researchers.

Through literature review, case study and discussion, the study due to the characteristics of SMEs to construct an integrated SMe-business model, CSFs and implement steps for SMEs. There is a lack of consistent, detailed research into how and why e-business is adopted. This paper has developed a holistic perspective which embraces sets of wider critical successful factors as well as more particular, integrated model which then contribute to the development of an e-business model and research propositions in order to address the situation.

Recommendation

The next stage in the research process will be the qualitative testing of the conceptual model. A series of in-depth interviews with managers of various sectors in SMEs will be

carried out. Qualitative data analysis will allow for adjustment of the model before larger-scale quantitative testing using a structured postal survey instrument. It is also the intention of the authors to carry out comparative research in order to identify CSFs and evidence of best practice. As the e-business SME develops in international markets, one additional area might involve the investigation of the usefulness of current internationalization models.

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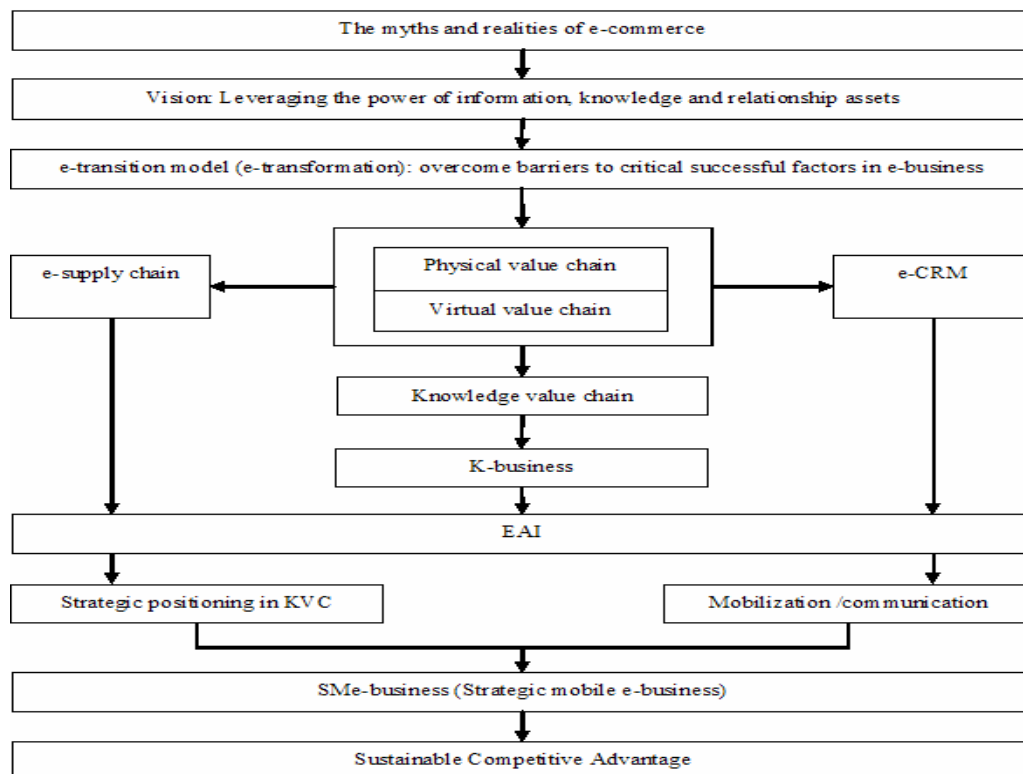


Figure 5-1: An integrated SMe-business model

E-Markets and Changing Trends

Mohini Singh

School of Business Information Technology

RMIT University

Australia

mohini.singh@rmit.edu.au

Abstract: This paper discusses the role of e-markets as intermediaries in the Australasian B2B e-space. The discussion and findings of this paper are from a research project that investigated the business and operational issues of these intermediaries as highly volatile business entities in 2002 and an evaluation of these same e-markets in 2005 to determine the changing trends. This paper presents business opportunities, revenue models from intermediary services, factors contributing to success and the challenges e-markets faced in 2002 and in 2005.

Keywords: B2B E-Business, net market makers, intermediaries, e-procurement, e-auctions, e-marketplace, e-markets.

I. Introduction

Since 1999 Australian businesses have increasingly adopted the Internet as a medium of doing business. According to the Australian Bureau of Statistics Report (2005) in the year 2004 75% of Australian business organisations were using the Internet and 25% had a web presence. B2B e-business in Australia is largely dependent on intermediation from net market makers either private, consortia based, national or international, to facilitate e-procurement, B2B exchanges, e-supply chain management and information sharing between business partners. B2B exchanges include various categories of market spaces, including vertical market portals, horizontal exchanges, hubs and various types of online auctions. Intermediaries generally referred to as net market makers or e-markets bring together exchange partners, organise and manage auctions, generate e-catalogues and other auxiliary services pertinent and relevant to efficient exchanges in the B2B e-space. Since 1998 Australian businesses have increasingly adopted e-procurement largely depending on net market makers to provide intermediary services and facilitate the exchange. As a result net market makers proliferated at an astounding rate because of the business opportunities in facilitating B2B exchanges. For buyers these intermediaries lower purchasing costs while reaching new suppliers. For suppliers they lower sales costs and help the supplier reach new customers.

However, as reported by Frew (2002), many of the net market makers that were announced in Australia in the year 2000 either collapsed or did not get off the ground. In the

year 2001 consolidation of some e-markets (net market makers) took place in Australia leading to B2B online exchanges becoming mostly industry specific verticals dominated by Australian buyers and sellers (NOIE, 2001). By the end of 2002 only about 100 e-markets (net market makers) existed in Australia (Frew, 2002). In 2004 several mergers and acquisitions took place and in 2005 synergistic takeovers are the trend.

Although the Internet offers great opportunities to net market makers, operational and business issues for success and survival as business entities have led these intermediaries to review and change their business and revenue models, services and operations. In this paper I present the findings of a research project that evaluated business practices, success factors and challenges faced by Australian e-markets in 2002 and in 2005.

II. Literature Review

E-markets (net market makers) offer services that facilitate transactional service needs to buyers and suppliers. Weill and Vitale (2001) and Zwass (2000) advocate that e-Markets enable easy search of products and services, information on product specifications which reduce communication costs for both buyers and sellers, dynamic pricing based on demand relationships, sales transactions that include payment and settlement, product delivery, market surveillance for stock market, auction results and enforcement of proper conduct by buyers and sellers.

Electronic intermediaries provide an information infrastructure by which traders can realise commerce over electronic networks (Lee and Clark, 1999). Deganaïs and Gautschi (2002) describe net market makers as organizations that own and operate the e-marketplace. Characteristics of net market makers according to Deganaïs and Gautschi are that these owners and operators may be companies that are fully independent (that is, are not also buyers or sellers) or could be major and dominant participants in the exchange as buyers and sellers. It is important for net market makers to adopt a business model that will allow them to operate the exchange and make a profit. These net market makers also depend on ancillary services to complete the exchange with support from electronic payment agencies, security system providers, and in some cases the engine (technology) to host auctions (Singh, 2004).

A business-to-business electronic marketplace has several buyers and several sellers. It is an arena on the Internet where a trusted intermediary (e-market) offers

trading functionality to registering companies (Swedish Trade Council, 2001). Whinston (1997) describes intermediary roles as facilitators of transactions between buyers and sellers with value-added services such as aggregation and distribution of product information, quality checks, and warranties. An electronic marketplace according to Archer and Gabauer (2002) is a virtual marketplace where buyers and suppliers meet to exchange information about prices and product and service offerings, to collaborate, and to negotiate and carry out business transactions. Gallagher and Ramanathan (2002) suggest that electronic marketplaces provide the basic infrastructure to allow suppliers and buyers to interact in an online environment.

Based on the above definitions, in this paper the terms net market makers and e-markets are terminologies used interchangeably meaning the same thing.

The large amount of bid, order and transaction management for the B2B procurement of parts and supplies usually require assistance from auxiliary services such as e-markets (Thomson and Singh, 2001, Laudon and Traver, 2002). An 'e-market' functions as a trusted intermediary whose well-integrated business procedures and technology save costs and streamline the purchasing and sales processes (Swedish Trade Council, 2001). They provide customers with buy and sell services to enhance business, efficiencies and competitiveness.

Three main functions that electronic markets serve according to Bakos (1998) are matching buyers and sellers, facilitation of transactions and provide trust and assurance. To match buyers and suppliers they help determine product offerings, price of goods, suppliers for the buyers and buyers for the selling companies. Facilitation of transactions includes logistics, settlement and trust. They provide trust and assurance with certification services and an infrastructure that is bound by legal and regulatory standards. There are generally different value propositions for buyers and suppliers to participate in a trading exchange or an industry consortium. Palmer (2002) suggested that buyer benefits gained from e-markets are easier and faster buying process, reduced transaction cost and time, reach to global community of sellers, easy access to a large amount of information, reduced search costs, streamlined business processes, a wider choice, quick order fulfilment and less chance of errors. For supplier benefits Palmer included cost saving and tighter inventory control, reduced transaction time and cost, broader customer base, information privacy and security, savings in time and capital, streamlined business processes, easy to update prices, availability and other product information, enable smaller regionalised suppliers a level playing field with larger suppliers and consolidation of orders onto a single invoice. Fairchild et al (2003) advocate that e-markets manage market process design, IT innovation and trust in B2B exchanges.

II. 1 Evolution of E-Marketplaces

According to Raisinghani and Haneback (2002) e-markets evolved in three waves of B2B e-business. In the first wave

there were approximately 1,000 independent online marketplaces for commodities such as paper and steel to specialised components such as airplane parts. Many of these were entirely dependent on transaction fees from a few large organizations, which could not remain in business as more organization-to-organisation dealings became possible. In the second wave large corporations formed a consortia designed to reduce bid-ask spreads and matching buyers with suppliers and enabling suppliers to trade with one another. In the third wave, exchanges customised their models based on the cost structures of various purchases. Some models focussed on collecting and distributing information, while others on reducing purchase costs and improving transactional efficiencies.

II. 2 How E-Markets Support E-Procurement

Business and government organisations in Australia and around the world are increasingly moving from paper-based traditional procurement to e-procurement, to capitalise on the efficiencies of price transparency, online catalogues, easy search for products and suppliers, and to capitalise on the benefits of technology and automated processes. While EDI has been the most common method for automating procurement, its extent was limited by its substantial cost that made it only accessible to large firms with recurring volume purchases (Pavlou and Sawey 2002). The more ubiquitous Internet, which is also economically accessible to small-scale B2B exchanges, has further advantaged e-procurement. Developments in B2B e-business in Australia has seen businesses and the government, both at the State and Federal levels adopting Web-based e-procurement to achieve volume purchase, dealing with a wider choice of buyers and suppliers, lower costs, better quality, improved delivery, and reduced paperwork and administrative costs (Singh and Thomson, 2002).

Businesses buy a diverse set of products and services, ranging from paper clips to computer systems, from steel to machinery. At the broadest level these purchases have been classified by Kaplan et. al. (1999) as manufacturing inputs and operating inputs. Business purchases are dominated by systematic sourcing and spot sourcing of goods and services. Systematic sourcing, buying through pre-negotiated contracts with qualified suppliers is relationship oriented and contracts are long term. Spot sourcing is fulfilment of an immediate need, typically of a commoditised item for which it is less important to know the credibility of the supplier (Thomson and Singh, (2001) and Chaffey, (2002) and Christiaanse, et al (2001)).

E-marketplaces or e-hubs that enable B2B purchases have been categorised by Kaplan et al (2000) as MRO (maintenance, repair, operating) hubs, horizontal markets that enable spot sourcing of operating inputs for manufacturing, labour, and advertising. Vertical exchange markets enable spot sourcing of manufacturing inputs and commodities, as well as vertical catalogue hubs for systematic sourcing of non-commodity manufacturing inputs.

E-markets support e-procurement by providing technology and governance solutions, auctions, electronic catalogue content, aggregating supplier input, industry news and standardised data access to buyers (Archer and Gabauer, 2000). Archer and Gabauer further explain that e-markets face the challenges of a balancing task as they set up solutions that satisfy suppliers and buyers ensuring that their costs do not outweigh the overall benefits they will receive from the arrangement, the need of a particular business model to determine which buyers and suppliers to recruit as participants and compete with other techniques that suppliers and buyers use to meet their needs.

II. 3 E-Markets in the Australian B2B E-Space

In the year 2000, many market makers (e-markets) proliferated in Australia due to e-procurement being the most important B2B e-business application. However, in the year 2001 consolidation of some e-markets took place in Australia due to online exchanges being new and unproven roles of these intermediaries (NOIE, 2001). A preliminary study of the e-market in Australia undertaken by Standing and Stockdale (2002) highlighted that initiatives such as 'try before you buy', free transactions, site tours and lengthy FAQ sections, strongly addressing security information were important features on e-market web sites. They also indicated that the most important means of revenue generation was a charge on transaction costs. Standing and Stockdale also suggest that Australian ownership of e-marketplaces is generally based on first mover advantage operating as intermediaries. These are either horizontal or vertical hubs enabling catalogues, auctions, exchanges, storefronts and negotiations.

Bryant (2002) is of the opinion that in Australia and New Zealand there are too many market makers for the size of the industry in this region. According to Bryant, most of these net market makers have similar offerings and flawed revenue models. Therefore to survive and expand business e-market makers need to build specialist businesses to support B2B e-business and look beyond their current business model.

E-markets in Australia do have an important intermediary role in e-procurement matching buyers and sellers, ensuring trust among participants, supporting market operations and transactions, ensuring quality control and aggregating buyer and supplier information. However, with evolving e-business models and technological developments, consolidation and liquidation of a large number of these market makers have taken place. Since 2002, e-market trends in Australia show mergers and acquisitions, synergistic takeovers and market consolidation.

An earlier research on net market makers in Australia (Singh, 2004) identified e-market intermediary business opportunities, revenue models, governance structure and e-market services in the B2B e-space. However, due to the changing trends of mergers, consolidation, huge competition and takeovers, it was imperative to evaluate e-markets to determine the changing trends in their business and revenue

models, business operations, success factors and challenges. Therefore the five e-markets that participated in the earlier research were contacted to identify changes in their business practices, governance issues, challenges and success factors. The method of investigation, findings and discussions are presented in the next section.

III. Research Approach and Methodology

This research project was accomplished via interviews, both face to face and telephone and email. Profiles were gathered from 5 companies operating as net-market makers in the Australian B2B e-space. The interviews explored company demographics, business model, practices and governance, success factors and challenges of these intermediaries operating as business entities, and changes in all of these after two years of operation. The 5 organisations investigated are those that agreed to participate in the project. Contact was made by email with the person who headed the organization, emphasising the importance of this research and agreeing to share the findings with these organizations. Five organizations were considered adequate for this study to help me identify the trends for further research. Interviews were semi-structured with open-ended questions to guide discussion about each firm's business practices, successes and challenges.

Data collected are summarised in Table One. The method of analysis is qualitative, inferences and implications of which are discussed in the following section. For reasons of confidentiality, names of companies discussed are not identified. In this paper they are referred to as Companies A to E.

Insert Table One

IV. Findings and Discussion

Company demographics, business practices, challenges and success factors identified from the findings are discussed in the following section.

IV. 1 Company Demographics

Organisations investigated were both large and small intermediaries in the B2B e-space. Companies B, C and E were privately owned while companies A and D were subsidiaries of international organisations. Companies B, D and E facilitated vertical hubs providing services to the construction, steel and supermarket industries, A and C facilitated horizontal and vertical hubs providing services to specific industries as well as exchange of commodities.

The respondents' positions ranged from senior consultant with the company to partner and director. Core services provided by these organizations included document tracking, online catalogues, strategic sourcing of suppliers, technology for online auctions, prequalification of suppliers and

facilitation of product sales in 2002. Additional services in 2005 included sourcing platforms, collaborative suites, exchange of specific types of goods such as perishables.

IV. 2 Motivation to Operate as Intermediary

Business opportunities from the Internet and e-procurement being the largest component of B2B e-business were the main motivating factors for these organisations to act as intermediaries. Company A saw a window of opportunity in the Australasian B2B e-business, thus decided to expand its operations in this region. Core services provided by these intermediaries included provision of technology for online bidding and auctions, sourcing of solutions and suppliers, document and transaction management and online catalogues. Company B capitalised on technology to reach out to global buyers of Australian Steel. Company D being a part of a large network of the supermarket industry facilitated large exchanges in the industry. Company E provided services specifically to the Steel industry and folded its business in 2004 due to a lack of participation from buyers.

In the 2002, it was apparent that opportunities arising from technology were a strong driver of net market makers to provide intermediary services and to operate as business entities. Another compelling reason to operate as a net market maker was first mover advantage in the emergent Australian B2B e-space. Although total revenue, profit and number of transactions still remain the motivating factors for e-markets, in 2005 developing B2B e-business from e-catalogues to a full suite, and supporting buyers with infrastructure was more compelling. Other reason was consolidation with industry or a take over by a more financially viable large organisation.

IV. 3 Business Models and Governance Issues

Companies A and C operated as neutral third parties supporting both vertical and horizontal exchanges, Companies B and D operated as vertical intermediaries supporting two specific industries the construction and supermarket. Vertical exchanges took advantage of the knowledge of the industry to target suppliers and buyers. Horizontal operators used advertising both formal and informal and allowed 40 % of the potential suppliers, based on prequalification and buyer selection to participate in any event. In most exchanges, the suppliers were known to the buyers due to the limited number of suppliers of some goods and services in this part of the world.

Value proposition to the buyers and sellers included transparency of information and prices, business efficiencies resulting from reduced costs of purchases, administration accuracy of data transmitted, reduced time for acquisition of products, scalable and reliable applications and improved and standardised business processes.

Findings of this research reveal that business models of intermediary operations in the Australian B2B sector of e-business are similar to those identified by Kaplan (2000), discussed earlier. However, new models of mega-

marketplace with supply chains suites are a consideration.

IV. 4 Intermediary Services

Intermediary services included provision of directories listing suppliers, their profiles and ratings; inventory listing; bulletin boards and online information browsing capability; information about the site and customer service, buyer guides and news. Creating e-catalogues and conducting reverse auctions, with online negotiations, RFQ's and document management and after event reports and payments were some of the other important services provided to buyers and sellers. Training users to use technology to bid online, access information and to negotiate online are also provided by these e-markets. Helping buyers participate effectively with technology and training support were incorporated by 2005. Other services for the horizontal smaller intermediaries included knowledge, project and tender management.

IV. 5 Revenue Model

The most common revenue model for services included a flat fee and a percentage of transaction fees charged to the buyer. Other sources of revenue included charges for technology for bidding and auctions, preparing e-catalogues and other small technology solutions. Company E charged a subscription fee for participating for servicing the construction industry. All charges were levied on the buyer. Prevalent payment methods used were traditional, although all had the infrastructure to support e-payments. Most received payments for their services 15 to 20 days after the event. Two respondents indicated that the fee charged covered costs but was inadequate. Low fees were maintained to attract business. New revenue streams identified in 2005 include fee for training, recruiting and licensing of technologies.

IV. 6 Strategic and Tactical Issues

Main business strengths identified were open source technology, skilled staff, a focused business model, technology for niche applications, holistic solutions encompassing services and technology, leveraging global knowledge base, applications of technology and first mover advantage in the industry. Competitive threats common to these organizations were other net market makers operating in the region and in the specific industry, as well as consulting organizations. Consulting organizations such as Peat Marwick and A T Carney provided B2B solutions as well as the engine for auctions. Business strategies for these e-markets focussed on business expansion, capitalising on technology, new and profitable business models, packaging of disparate issues for simplified solutions, new partnerships for business growth. To form new alliances with organizations that can support software development, content, e-catalogues, payment services and technology.

The findings in 2002 indicated that e-markets faced stiff competition, and their strategy is focused on growth and expansion. Technology can be capitalised on for

differentiated services and integrated solutions to lock in customers.

In 2005 moving onto the next round of B2B e-business with winning business models to create value for customers as well as creating profits and sustained growth in shareholder value was emphasised to be the strategic consideration. Communication hubs with supply chains and reverse logistics management to foster better participation from buyers and suppliers are considered.

IV. 7 Infrastructure Issues

Infrastructure for managing an electronic marketplace varied for all the respondents. Company A, which is a subsidiary of an international net market maker owned its e-marketplace platform called 'Bidware' which supports global markets and hosted on a server in Pittsburg. Companies B and E supported vertical exchanges with privately owned technology either developed or modified in house to support the online exchange. Company B's platform required participants to make their bids from their personal computers. Company D used technologies supported by international partners. Company E was based on open source JAVA and LINUX.

From the above it is clear that e-market services are not technology specific and can be operated from different platforms. The need for a seamless integration of procurement data and the back end system is essential for online realtime processing of information. Information technology is the backbone to B2B e-business exchanges. In 2005 this finding was the same with convergence and consolidation of technologies for additional services.

IV. 8 Success Factors

Success factors identified in 2002 were skilled and motivated employees, a focused business model, first mover advantage, open source technology, e-market technology compatibility with internal business processes, knowledge of the industry, a good value proposition to participants, and Australia's limited supplier base.

Technology and business knowledge of the market makers, need for support in B2B exchanges with the increased application of the Internet, and a well planned business model clearly lead to first mover advantages in innovations such as e-procurement and e-business.

In 2005 intermediaries operating vertically supporting industry specific exchanges were more successful in getting business. Ability to incorporate new and diversified offerings also supported business.

A regulatory framework to guide e-procurement and e-market facilitated exchanges now exists in Australia that provides assurance and trust in the application.

IV. 9 Challenges

Challenges faced by net market makers identified in 2002 were clearly more than benefits. The most common ones were the small size of the industry in which they are operating, fragmented market, a lack of belief in the industry

that e-market will work, undoing the legacy of existing markets, old inflexible back end systems, credibility issues due to the small size of the company, limited access risk capital in Australia, fear of change to a new way of doing business, negative perception created by the collapsed and unsuccessful market makers, a lack of trust, education and awareness of the benefits of e-marketplaces.

The above findings indicate that overcoming conservatism, finding a champion in the organization to promote the role of e-market services in B2B exchanges, the need for a leader company in the industry to support net market maker services, breaking existing supplier and buyer relationships, convincing buyers and sellers of the benefits achieved from intermediary services, the need for standards to support trust and security, winning investor confidence and overcoming internal resistance were hindering the growth of e-market operations.

In 2005, challenges were much the same with an emphasis on slow uptake of electronic exchanges. Company E folded business due a lack of interest from steel buyers trading online. New business models with an emphasis on value rather than price is an important consideration.

V. Conclusion

From this research it is apparent that technology opportunities gave birth to a new type of business, the intermediary services. It shows that the internet offers opportunities to buyers and suppliers in the B2B e-space to automate transactions, expand offerings to business partners, launch catalogues, e-procurement sites, auctions and communication. Some intermediaries service only vertical industries and some provide services horizontally. All emphasise on the efficiency to reach out to and be gained by bringing together buyers and sellers in an electronic marketplace.

Business models of e-markets are predominantly neutral third parties operating in the horizontal, vertical or both horizontal and vertical markets. However, the need to move from buyer-oriented, buyer-seller oriented and seller oriented to mega-marketplaces offering combined products and services, a transport network, communications hub and markets where products can be changed across manufacturers are being considered for next generation business to business exchange services.

Despite technical challenges e-markets are faced with the challenges of buyer and seller participation and changes to their sourcing systems. It is a very competitive business which is indicative of the need for new, innovative and integrated services and business strategies for revenue expansion and future survival.

An evaluation of the e-markets shows that although they are now more experienced and capable of offering better services, becoming industry specific or diversifying services is the new trend for capturing value.

It also highlights the fourth wave, which is merges and consolidation with new and diversified services. New

revenue and business models are also evolving.

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Table One

	Company A	Co B	Co C	Co D	Co E
Demographics & Business Motivation	New, small, international parent co., Business opportunity	New, small, local, Melbourne Business	New, small, Melbourne based Business opportunity	New, large, Australasian based Business opportunity	New, small and privately owned Business opportunity
Bus Model & Governance	Vertical & horizontal	Vertical	Vertical & horizontal	Vertical	Vertical
Services	Auctions, catalogues, RFQ, participant selection	Forward auctions	Reverse auctions, search, catalogues	Communication , connection & collaboration, Auctions	e-catalogues, tendering, search assistance
Revenue Model	Flat fee & charges for exchange services	Transaction fees	Auction & service fees	Training, volume transactions, auctions	Software, training users, negotiations
Strategic Issues	Holistic solutions	Niche applications	A focused business model	Industry specific	New services
Infrastructure Issues	Bidware	Developed in-house	Developed in-house	Sourcing on buyer desktop, full category sourcing	JAVA/LINUX
Success Factors	Previous experience, proven technology & business practice	Industry knowledge	Industry & technology knowledge	Technology	Industry knowledge
Challenges	Sparse transaction volumes Slow uptake & dev	Seeking alternative services for revenue	Competitors Slow development s	New horizons & trends	Resistance & fear of unknown

An Evaluation E-Commerce Performance in Hotel Businesses Using Balanced Scorecard

Patthanid Cheangtawee* Prasong Praneetpolgrang** Natsapun Paopun***

*Master of Business Administration (Electronic Commerce)
Graduate School, Sripatum University
61 Phaholyothin Rd., Jatujak 10900 Bangkok, Thailand.
Email : patthanids@hotmail.com

**Master of Science (Information Technology)
Graduate School, Sripatum University
61 Phaholyothin Rd., Jatujak 10900 Bangkok, Thailand
E-mail: prasong@spu.ac.th

***Master of Business Administration (Electronic Commerce)
Graduate School, Sripatum University
61 Phaholyothin Rd., Jatujak 10900 Bangkok, Thailand
E-mail: natsapun@spu.ac.th

Abstract: In the modern business world, the IT advances accelerate the world's commercial development with the help of Internet technology in supporting variety of activities. As a result, e-commerce play a significant role in almost every industry. Hotel industry is one of those which are fully beneficial from the e-commerce, which fulfills the customer's needs. This research is conducted to study the character of the hotel e-commerce and the measurement of performance of the hotel e-commerce in Thailand in all perspectives of Balanced Scorecard.

In the research, the researcher uses the reasoning approach to describe the relationship between the variables of causes and effects whose directions are precisely specified. The samples of the research are the hotels in the Bangkok metropolitans and vicinity areas. The researcher uses questionnaires to measure the customer satisfaction of business operations according to the Balanced Scorecard. Then, the initial collective information is analyzed to categorize those samples in percentage. Next, the result of the satisfaction based on Balanced Scorecard measurement is tested for the relationship of all variables by using the statistic of interrelation and chi-square values.

The result of the research provides us the character of operating of the hotel industries and the sufficiency of operating e-commerce of hotel industries in Thailand. In addition, it can be used as a guideline in hotel business development which enhances the capabilities of performance and competition.

Keywords: e-Commerce, Performance, Balanced Scorecard.

I. Introduction

Tourism industry can make incomes to many countries and

enormously pull foreign currencies into the country. Consequently, tourism market has speedily grown. World Tourism Organization estimates that in the year 2020 over 1.5 billion tourists would take international journeys. Europe would still be the most popular tourist place. Second to Europe, Asia Pacific would welcome up to 397 million tourists. The growth rate is average as 6.5% per year [1].

Tourism industry shows a satisfactory growth rate. Anyway, what follows is a highly competitive situation. As known, tourism can bring foreign currencies to the nation's economy at a quite fast time so many developing countries have turned to give an importance to tourism by emphasizing on tourism development as the initial issue in the National Social and Development Plan. Developed countries have also developed their tourism. In the Asian Pacific region, Thailand is one of the tourist destinations due to the natural uniqueness and prominence. Market share of tourism in Thailand is expected to be growing up. In 2020, there would be around 37 million tourists, or 63% increase, to visit Thailand. To respond to such situation, we should develop our tourism industry in all perspectives in order to be internationally competitive.

Currently, hotel business introduces e-commerce to various kinds of work such as internet booking, self-plan tour, hotel information providing in terms of location, type, room price and facilitations, e-mail correspondence, raw material purchase to supplies via internet and online payment. All these facilitate more effective operation. Nevertheless, the business has not evaluated the application of e-commerce to business. So, to be the approach for the evaluation, the objectives of this research are to study the feature of e-commerce in hotel business in Thailand and to develop the effectiveness indicator of e-commerce as to the principle of balanced scorecard. Indicators will be considered from work systems of hotel in four perspectives: financial, customer, organization internal, knowledge and development and will be set up from factors internally and

externally affected. It would be quite beneficial to introduce balanced scorecard to hotel business for performance evaluation and more effective development and improvement of operation.

II. Related Research

II.1 E-Commerce Principle

E-Commerce means any economic activities between at least two persons or businesses conducted on electronic network such as booking, purchasing, negotiating, bidding, paying, advertising, service providing and transactions in other forms, which may occur within a company such as designing, product manufacturing, coordinating, payment transaction. This can be conducted by business to business, business to customer, customer to customer or business to government sector or other kinds, which may late define by the development of e-commerce [2].

From the research of Somnuek Kirito and Phumsak Smutkhup conducted a study on the approach of the development of e-commerce indicator progress in Thailand [4]. From the research, it was found that firstly, the definition and concept of e-commerce should be clear for simple understanding and good survey. If there was no standard definition, the survey would lack reliability and accuracy and would not bring the result to compare in the international level.

E-Commerce Division [2] conducted a study on the evaluation of e-commerce in Thailand as to the principle of Balanced Scorecard such as. The samplings were the entrepreneurs who registered their websites with the Ministry of Commerce. There are 4 main perspectives of Balanced scorecard 1.customer, 2. knowledge and development, 3. internal process and 4. financial were referred for the analysis. Moreover, other perspectives as marketing and information technology and e-commerce were evaluated. From the study, it was found that, in financial perspective, most companies started the business from their own capital so they were small and bore no many expenses. This was good to e-commerce. However, the disadvantage was they were not much considered. For customer perspective, the business gave an importance to customer service by creating relationship and good impression to customers. What was found was that the increasing numbers of customer was rather low. For internal process perspective, most businesses tried to introduce e-commerce and technology to improve the quality of service. For the knowledge and development perspective, most business had growth potential because the entrepreneurs and executives had good education and moderately understand e-commerce features but lacked e-commerce marketing training to their staff and lacked marketing survey so the long-term problem would be faced because of no suitable product development for the market.

II.2 Balanced Scorecard Concept

Balanced Scorecard has been generated by Professor Robert Kaplan and Dr. David Norton who conducted a study on the cause of the US stock market difficulties. This was due to the most use of financial indicator so they thought of other 4 perspectives to evaluate an organization, namely, financial perspective which reflected the financial performance, customer perspective which reflected customer satisfaction, internal process perspective which was the improvement of internal process to respond to financial purpose, knowledge and development perspective which reflected the satisfaction of staff and how to maintain staff with the organization [6].

Wim Van Grambergen and Isabell Amelinckx [7] conducted a research on "Measuring and managing e-business projects through the Balanced Scorecard". They studied the e-business management evaluation by balanced scorecard and found that for the investment in former e-business, ROI, NPV, IRR, PB were considered and these were only the financial result because the executives saw that decision making on investment had to rely on financial perspective. This overlooked other relevant points. BSC helped the executives to consider other perspectives because BSC allowed periodic monitoring and report to the executives so that they could know BSC problem and could adjust to more effective indicators.

II.3 E-Commerce in Hotel Business

The past adjustment of hotel to technology still relied on wholesale partner. Anyway, when internet played an important role, new customer group occurs. Each hotel advertisement was rather troublesome and spent many budgets. After internet introduction, hotel can create their website, design and input details with tiny expenses and is available for new-generation tourists from all over the world, who enjoy searching details and new lodgment from websites.

Sansakon Phikunkheha [3] conducted a feasibility study on e-commerce investment in hotel operation: case study: Chiang Mai Orchid Hotel on 4 perspectives: techniques introduction of e-commerce to hotel operation technology could highly facilitate the hotel operation, marketing the higher the competitive situation was, the higher the customer's bargain power would be, management the information providing in e-commerce in hotel business was not high but the reservation and payment through internet system was rather risky. Hotel should have readiness of specialists, financial – NPV should be at 2.6 years and IRR should equal to 64.97%. From this, it is possible to introduce e-commerce into hotel business.

III. Research Methodology

In the research, the researcher uses the causal research to describe the relationship between the variables of causes and effects whose directions are precisely specified. The samples of the research are the hotels in The Bangkok metropolitans and vicinity areas which standardized by Hotel Standard and Tourism Authority of Thailand and Association of Thai

Travel Agents. The researcher collects information by tool such as questionnaires. The first questionnaire asks the questionnaire of his or her profile to analyze his or her qualification by the measurement of mean and percentage. The second part asks the opinions of the four parts according to the Balance Scorecard to analyze the satisfaction using the statistics of Correlation Coefficient and Chi Square. This tests the relationship between the variables of causes and effects. And the third one is to investigate suggestions after applying business into e-commerce.

IV. Preliminary Results

The study shows that some groups of hotels industries understand that the e-commerce are e-mail, online reservation, and Web sites. Here are some examples of statistics. 18.2% of them purchases goods and services via Web sites, 12.7% use internet banking, 10.6% pays bills through Web sites and takes distance learning, and 8.5% experiences online auction respectively 5.2%.

In terms of monetary measurement, the study finds that the average monetary efficiency as a whole is in a higher position after adopting e-commerce. It increases the revenue from foreign customers and sales also crease during the promotion. After adopting the e-commerce, hotels also gain better images. customers recognize their images, services, and activities. Hotels that accept e-commerce gain more new customers each year.

In terms of interior operation measurement, the research finds that the interior operation efficiency average is in a better position after adopting the e-commerce because it accelerates communications with customers. This enables a better customer service and better reservation management during the high season. It also provides a sufficient communication with customers due to a more sufficient planning.

In terms of learning and growing, the study finds that learning and growing is in a medium level. After adopting e-commerce, hotels are ready for TI since they invest more in technology and employees learn more about their organization and have a better view of the organization. Hotels of e-commerce also provide computers as tools which enhance the employees' skills.

In conclusion, according to the four perspectives of Balanced Scorecard, the operation is involved with e-commerce efficiency.

V. Conclusion

To use e-commerce in business sufficiently, hotels should measure the operation after adopting the e-commerce from time to time to observe the business growth. This will make it clear that e-commerce investment is beneficial to their business. Research shows that e-commerce improves the

operation and enable the business to grow. For a better result, organizations should train employees about the new technology so they can get the best out of it. In addition, the government should improve the law about the e-commerce to ensure the credibility among the service providers and customers of their Web sites since the confidence of e-commerce in Thailand remains unreliable. This is one of the significant steps for hotel industries whose growing customers are mostly foreigners.

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Study on Risks of Medical Industry Ecommerce Based on Supply Chain Management

Shifeng Liu*, MinCong Tang**

* Information management department, Beijing Jiaotong University, Beijing China
Tel: 86-10-51688529 Email: Shifeng.liu@263.net

** Department of Decision sciences and managerial economics,
The Chinese University of Hong Kong, Hong Kong, China
Tel: 852-26098560 Email: mincing@baf.msmail.cuhk.edu.hk

Abstract: From the point of view of cost-reduction and benefit-improvement, this paper puts up with a new E-Commerce mode for the medical industry—E-Commerce based on supply chain management (SCM). At the same time, this paper qualitatively analyzes the risks of the mode, including risk of management, risk of technology, risk of human resource and risk of the mode itself. At last, the paper puts forward a set of risk management models for this E-Commerce mode according to the basic principles of project management.

Keywords: E-commerce; Risk analysis; Medical industry; Management; Model.

I. Introduction

The medical industry is a traditional basic industry with very wide development prospect and it is also one of the industries of the national economy with the fastest developing speed. China has already become the big medical country of the world.^[1] The medical industry of China has already built up comparatively perfect industrial system and circulating network. The output and kinds of the medicine stand on the top of the world. The medical industry is now breaking the yoke of long-term planning economy and the property right structure is being developed in the pluralistic directions.^[1] Furthermore, the opening of medical industry has made great achievement. At present, the most important thing for the development of medical industry lies in how to utilize the modern information technology means to tackle the opportunity and challenge of joining the World Trade Organization (WTO).^[1]

The medical industry E-Commerce refers to the medical trade platform that the network members include the medical organizations, pharmaceuticals, banks, medicines manufacturers, medicinal information service providers and insurance companies.^[1] And it offers a safe, reliable, open and medicinal trade platform for users that is easy to maintain.

II. Medical Industry E-Commerce Based on Supply Chain Management (SCM)

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II. 1 Basic Principles of E-Commerce Based on SCM

The basic principles of E-Commerce based on SCM lies in "Greatly lower costs by reducing intermediate links of medicine supply chain utilizing the basic principle of supply chain management, which can really show the advantages of E-Commerce over traditional trade". The supply chain here means the concept that "the third party supply chain management service". It is a very creative mode and its service range is showed as the figure below.^[1]

II. 2 the Make Up Of E-Commerce Based On SCM

The center of E-Commerce based on SCM lies not in technological solution, but technology is the supporting platform of this mode to launch supply chain management service. From the view of technology, E-Commerce based on SCM can summarize as "three system, building databases on two levels". The three systems so-called include an E-Commerce website, a regional home-delivery center website and the chain drugstore management system. "Building databases on two levels" means regional medicinal database and national medicinal database.^[1]

The above-mentioned content constitutes the basic support of forming the E-Commerce based on SCM. This can show as figure 2.

In E-Commerce based on SCM, the main functions of all the components should be as follows:

- 1) **E-Commerce website:** it is a window for the E-Commerce platform for the mode. It collects key data in all areas in the country, and it is responsible for analyzing the industry and issuing information.
- 2) **Virtual local delivery center:** It's the operational center of the mode, which takes charge of the supply chain management for local area and it also corresponds to information service. The center adopts organizational form of "virtual enterprise", which is organized according to the requirements of "three kinds of companies, two kinds of supporting systems" for the third party supply chain management service. Essentially, it is a virtual delivery center based on Internet. What is called "three kinds of companies" is used to indicate the three parties of "virtual enterprise". The three parties are companies that provide the third party supply chain management service, medicinal wholesale companies (the companies of low reaches)

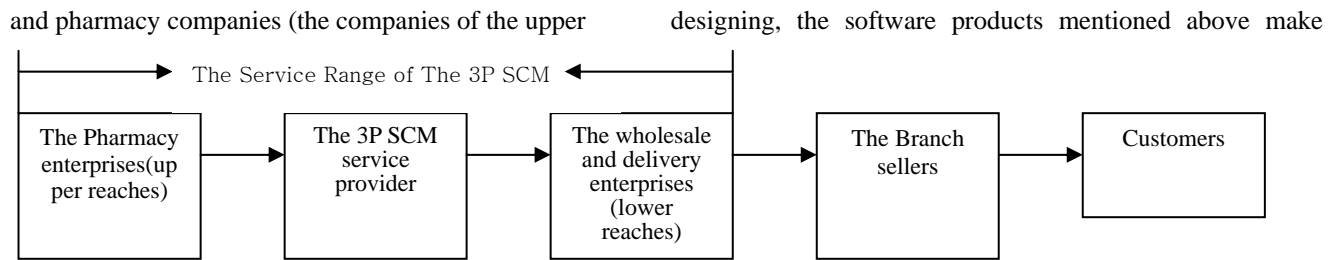


Figure 1: The Service Range of the 3P SCM

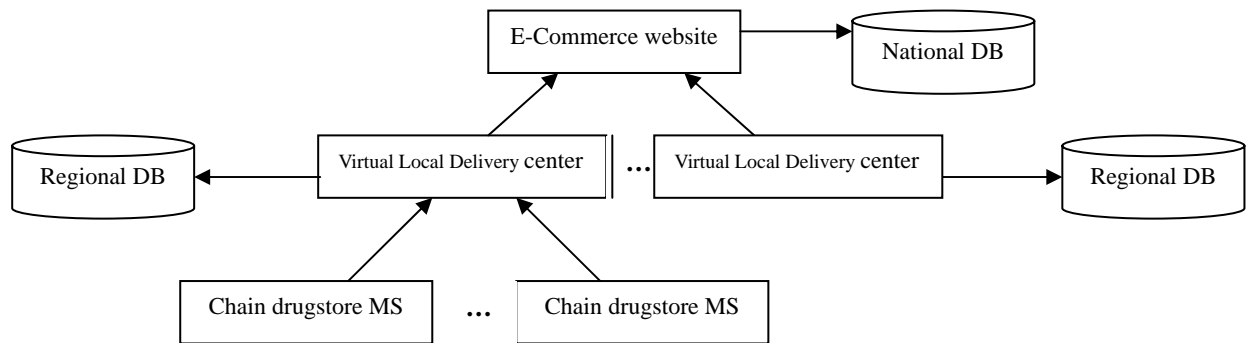


Figure 2: Support Platform for E-Commerce Based On SCM

reaches). The two supporting systems refer to regional delivery center websites, which orientate to medicinal trade services in certain area and logistic delivery system.

- 3) **The chain drugstore management system:** It is the supplementary part for operations of the mode, it aims at medicinal chain enterprises and it offers the internal informatization solutions for enterprises. It mainly acts as “a stepping-stone to success” among the whole E-Commerce mode system. The chain drugstore management system is mostly used to collect sales data of each drugstore and upload them to regional database.

III. Risks of E-Commerce Based on SCM

Risk refers to the possibility of loss or injury.^[2] To analyze the risk of this E-Commerce based on SCM, this paper defines the risks from several points of view.

1) **Risk of human resource:** this kind of risk refers to the condition under which senior employees who carry this mode for a corporation quit. The design of service product, management decisions and organization will all be influenced. If important technical staffers leave the company, software technology will lose. This means the decline of research ability in the company and accordingly the mode will probably be lost. If the relevant employees of marketing department leave, the customers of this mode will be influenced.

2) **Risks of technology:** E-Commerce website, regional home-delivery center website and chain drugstore management system are main technical support platform for the mode to be realized. Though during the course of

every effort to keep being in the lead. With the progress of science and technology, there will be more advanced technology, especially in the industry of the computer. The speed of renewal of knowledge will be very fast. This forms the risk of technology, which will result in backwardness of developed software performance and suitability and then lose already existing market competitive abilities.

3) **Risk of management:** Managing risk mainly comes from reliance on main administrators and the management and administration integration capability of administrators. Companies implementing this mode must have better cohesiveness. If the main administrators left the company because of various kinds of reasons, this mode is difficult to operate according to the established route successfully. In addition, if administrators have inadequate experience on management and inaccurate knowledge to realize what market demand, all these will cause risks, such as marketing insufficient, new product lacking of suitability and managing enterprise improperly, thus they enable expecting benefit discounted.

4) **Internal risk:** the characteristics of this mode lie in that it offers the third party supply chain management service. From the analysis above we can

IV. Risk Management Model for E-Commerce Based on SCM

What is most important for risk analysis is how to manage the risks and avoid loss. Therefore, basing on the qualitative analysis of the risks of this kind of E-Commerce mode, this paper will put forward a set of risk management models that

is based on the principle of project management for E-Commerce based on SCM, including risk identification model, risk assessment model and risk monitoring model.

IV. 1 The Six Processes of Risk Management

In the book "IT Project Management" written by Kathy Schwalbe, the author made a summary of the processes of risk management. The major processes involved in risk management include:^[2]

Risk management planning, Risk identification, Qualitative risk analysis, Quantitative risk analysis, Risk response planning and Risk monitoring and control. The six processes above could be described as the follow figure3. This is the basic principle for the risk management model put forward in this paper.

IV. 2 Risk Management Models for E-Commerce Based On SCM

IV. 2. 1 Risk Identification Model--Fault Tree Method

This paper considers that it is a good way to identify the risk of the E-Commerce mode with the fault tree method. This method uses a graphic way to divide a large risk into several kinds of small risks. Or analyze the reasons for the risks. This is an advantageous tool for risk identification. In analyzing the risks of the E-Commerce mode, this method uses a tree-shaped figure to describe the risks of the E-Commerce mode with a way of from roughness to details and arrange according to different levels. It is easier to find all the risk elements because of the definitive relationship among them. The principle of fault tree method shows as the figure 4 below.

IV. 2. 2 Risk Assessment Model--Risk Assessment Table

There are many methods for risk assessment. In this paper, the method "risk assessment table method" would be adopted. During the procedure of risk analysis, a four-dimension array would be built.

$$Array=[R_i, L_i, X_i, Y_i]$$

In this array:

R_i --Risk;

L_i —the possibility of the risk;

X_i —the loss of risk;

Y_i —the expectation of risk

To most of the IT project like the medical industry E-Commerce based on SCM in this paper, the risk factors including the cost of development, cost for human resource, technological support, the performance of the web platform constitute a typical frame of reference for risks. That is to say that there exists an average at which would lead to the termination of the project if one of the following situations exists: the development cost exceeds, difficult to technological support, cost of human recourse exceeds and so on.

In the analysis of the risk for the E-Commerce mode, if one or more factors exceed the average, the project would have to be stop.

If the risk of the E-Commerce mode reaches the critical point, then it could be judged from the performance analysis, cost analysis and quality analysis to decide whether the project should be terminated or not. This paper takes the software (web platform) and the development cost as an example. Showed as figure 5 below.

In reality, the reference point usually forms a easily changeable section but not the smooth curve showed on the figure 5. Therefore, this paper considers that when assessing the risk for the E-Commerce mode, the following steps should be followed.

- 1) Define a risk average reference value;
- 2) Find the relationship between each array of [R_i , L_i , X_i , Y_i] and its risk average reference value;
- 3) Assess an array of critical point for the termination section of the E-Commerce mode;
- 4) Assess how the risk assemble influences the risk average reference value. That is the extent to which the project should be terminated.

The following table1 is a risk assessment table, which is made up of risk, possibility of loss, loss and the expectation by using the platform performance and cost of development as frame of reference.

Table 1: Risk Assessment Table

Risk R_i	Loss possibility L_i	Loss X_i (US\$)	Expectation Y_i (US\$)
Not support multi-users	30%	5000	1500
Sloe database connection	20%	4000	800
difficult to re-development	50%	25000	12500
Difficult to update or maintain the database	30%	12500	4000
not friendly user interface	20%-30%	2500	1500-2000

In table 1, the persons who are familiar with the platform should confirm the loss possibility. For Example, using the Delphi Method. Each person assesses the every risk independently, and discusses the reasonability of each assessment round by round until the final decision reached.

IV. 2. 3 Risk Monitoring Model

Since it is difficult to determine the influence of time on the E-Commerce mode, therefore, risk monitoring becomes an important job for implementation of the E-Commerce mode. Risk monitoring refers to monitoring the products (here mainly refers to the platform and the management system for chain medicine stores), the progress of the project and the change of environment. Under most condition, the information will increase with the time, the uncertainties would descend and the risk-monitoring job would be more and more complex. Risk monitoring for the E-Commerce

mode here is mainly executed by experienced management staff. It adopts the prototype method in project management,

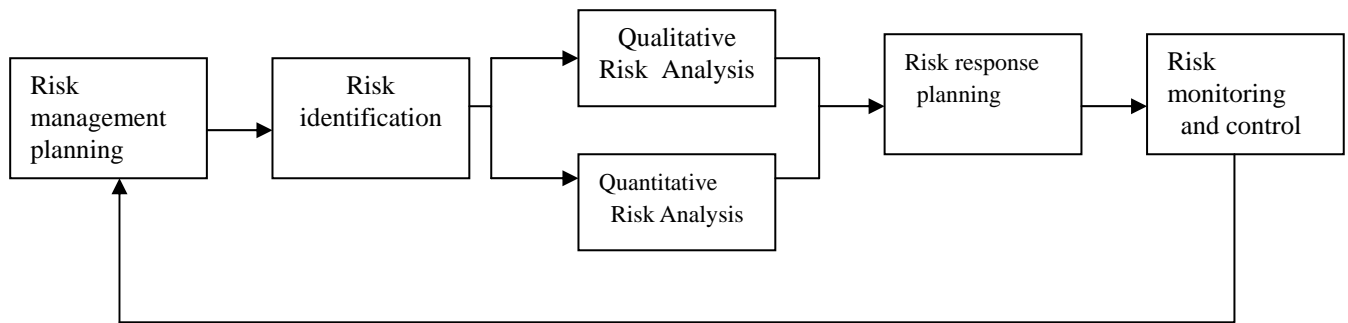


Figure3: Six Processes of Risk Management

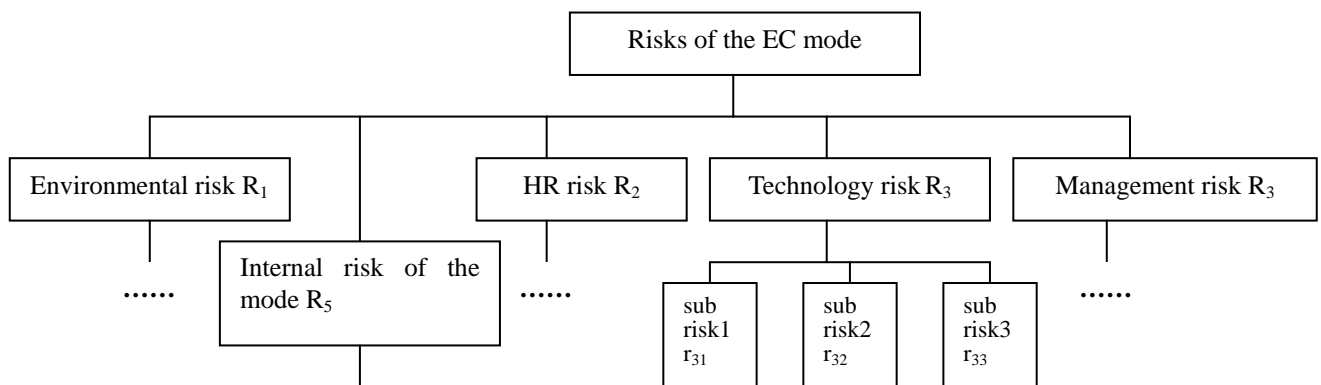


Figure 4: Principle of Fault Tree Method

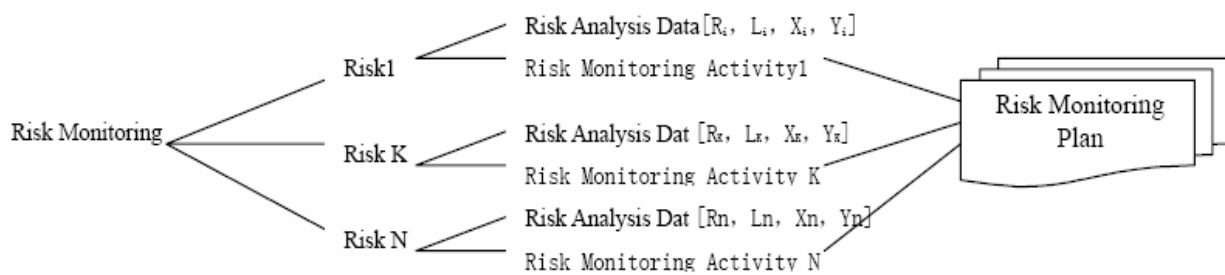
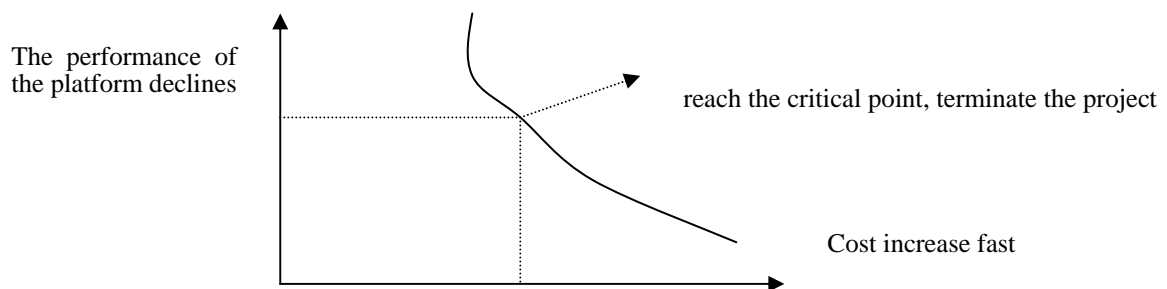


Figure 6 : Risk Monitoring Activities

software psychology and so on to avoid and transfer risks. This risk monitoring activities could be showed as figure 6. That is risk monitoring activity, in this paper, the method “ten risk events listing table” is adopted as the best efficient tool for risk monitoring. It is a tool that could keep a sense of risk through the whole life cycle of IT project, so as for the E-Commerce mode here. The listing table includes: the rank at present, the rank of last, the number of occurrence on the table in a special period and the avoiding progress for the risk. Table 2 is an example for the E-Commerce mode risks event list. The project manager checks the table every week and re-considers the risk events and pays more attention to the changes happen.

Table 2 Ten Risk Events Listing Table

Risk Event	Rank of this month	Rank of last month	Number of occurrence	Risk avoiding progress
difficult to re-develop	1	2	3	redesign the database
bad design	2	4	2	design according to the norms
could not submit the developing tools on time	3	5	5	the purchasing department has regarded it as the highest priority
not well planning	4	1	2	modify the whole plan
...

V Conclusion

Medical industry E-Commerce develops very fast in China as well as all over the world. And its development would take place in a more and more complex and dynamic environment that included high levels of uncertainty and risk.

In this mode for the medical industry E-Commerce, investment risk would be most highly concerned since the revenue would be low at the beginning of the project. As a result of fact, legal measures would have to adopted to preventing the investor from withdrawing his or her investment. Moreover, human resource risk is also an important concern. It is a new project for the study of risk of E-Commerce development, here this paper could not describe every aspect in detail. And this paper only provides a set of theoretical methods for risk management of E-commerce development both for medical industry and other industries; it should be penetrated into further research.

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Analyzing the Role of Interorganizational Systems on Coordination Cost between Firms

Geng Zhang, Zhenyu Liu

Department of Management Science, Xiamen University, Xiamen, P.R.China, 361005
zhanggeng001@126.com, zhenyliu@xmu.edu.cn

Abstract: It is believed that the adoption of Interorganizational systems (IOS) can enable organization to use the information processing capabilities to reduce coordination costs and improve performance. However, the past researches have shown mixed results about the impact of IOS on coordination costs. While drawing on transaction cost analysis, this paper suggests that analyzing the association of IOS use and coordination costs of interorganizations should consider different levels of asset specificity. To illustrate the explanatory power of this analysis, this paper presents a case study from China. The findings from the case study show that, when asset specificity is high, IOS use can reduce coordination costs for monitoring or cooperative purpose. While under a condition of low asset specificity, the association between IOS use and coordination costs is negative.

Keywords: E-commerce management, Interorganizational system, Coordination cost.

I. Introduction

The recent increased interests focused on cooperative relationships across organizational boundaries have put great emphasis on interorganizational system (IOS) issues. IOS is firstly defined by Cash and Konsynski [5] as “an automated information system shared by two or more companies”. These kinds of systems are different from intra-organizational and distributed information systems by exchanging information across organizational boundaries. Although a number of researchers have demonstrated that in an interorganizational relationship, the adoption of IOS could enable organization to use the information processing capabilities to decrease costs and strengthen relationships among participating organizations and as thus improve performance [17], the past researches have also shown mixed results about the impact of IOS on the performance of participating organizations. For instance, Hengst and Sol [11] have introduced transaction cost theory to study the impact of information and communication technology (ICT) on coordinate activities among organizations. They argue that using of ICT can lower coordination costs and they assert there exists a positive relationship between benefits gained from coordination and the level of ICT applied. But on the other hand, they acknowledge that using of ICT will

also increase the complexity of coordination, such as inducing more communication activities and more information processing.

Such problem implies that we should analyze the impact of information system in coordinating activities among organizations under different conditions. This paper addresses this problem by analyzing how the use of IOS affects coordination costs under different levels of asset specificity. Based on our analyzing method, this article presents a case study about IOS using of a manufacturing firm from China. From this case study, we try to investigate the attitude of firms towards the effect of IOS use under different environments.

This paper, in the next section, reviews the primary contributions and arguments of transaction cost analysis in the context of interorganizational relationships. In the subsequent section, we present hypotheses to discuss possible directions to the impact of IOS use on coordination costs among firms under different conditions. Next, we describe the case study from perspectives of managers to explain the power of this framework. This paper ends with conclusions and directions for future research.

II. Implications of Transaction Cost Analysis

Transaction cost analysis (TCA) has focused on the appropriation concerns in interorganizational relationships, which are originated from pervasive behavior uncertainty and contracting problems. The basic assumption underlying the TCA perspective is that the specific governance form is based on an economizing on transaction costs. Williamson [18] argues that the total costs of an organization are consisted of production costs and coordination costs. An organization should choose a proper governance form according to a trade-off between the advantage of low coordination costs in the case of hierarchies and low production costs in the case of markets.

Asset specificity and environmental uncertainty are the key dimensions of TCA that are used to predict the boundaries of a given firm. The concept of environmental uncertainty plays a major role in TCA which is referred to circumstance surrounding an exchange cannot be specified *ex ante*. Considering environmental uncertainty is beyond the control of an organization, we take environmental uncertainty being substantial as the premise of our analysis.

Asset specificity refers to physical assets, production facilities, tools and knowledge tailored to a specific relationship that cannot be re-deployed for other purposes without the sacrifice of productive value. When entering an

interorganizational relationship, participants usually have to invest on assets with specific use only in this relationship. As regarding the manufacturing industry, a firm should, which is looking for appropriate supplier, make great effort on searching and evaluating the potential partners. This may consume a lot of capital, labors and time to establish and maintain the cooperative relationship. Besides, the participants might take the risk to be locked-in by special production equipment, computer technology and related interorganizational systems that link the buyer's and supplier's scheduling and production activities. As asset specificity becomes substantial, interdependency is deepened and coordination is needed for safeguarding the appropriation concerns.

Past researches have studied the association of coordination costs and asset specificity under substantial environmental uncertainty [2][4][9]. Their findings suggested that substantial asset specificity would create bilateral dependence and reduce the firm's control over its business partner. Therefore, the firm's coordination costs might increase [2][8][9]. For example, in the study of buyer-supplier alliance, Anderson and Buvik [1] have confirmed that the association between buyer's asset specificity and buyer's coordination costs was positive. Figure 1 illustrates the association between coordination cost and asset specificity.

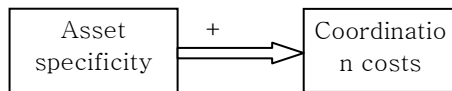


FIGURE 1: Association between coordination cost and asset specificity

III. Analysis of IOS and Coordination Cost

With the rapid development and diffusion of computers and telecommunications in the past decades, organizations can be able to extend the range of cooperation with other organizations based on information systems. Initially, the adoption of Interorganizational systems enables participating organizations to use the information processing capabilities to improve performance and to strengthen relationships with other organizations sharing the IOS. Therefore, IOS are widely adopted in industries such as airlines, banking and transport [17]. Nowadays, it is realized that cooperation and interdependence with other organizations are vital and information technology is an important enabler to such interorganizational activities. To address the influence of IOS, some researchers have investigated the efficiency advantages in transactions gained by IOS. Malone et al [14], Gurbaxani and Whang [10], Clemens et al [6] point out that using of IOS has a positive impact on the cost to coordinate activities between organizations and leads to competitive advantages. At the same time, other researchers have

identified disadvantageous effects of using IOS, such as the risks of becoming locked in with system and relationship specific investments and the issues of changes in bargaining power between firms [3][6][13].

We argue that the mixed findings about the effect of IOS on interorganizational coordination cost relate to the influence of asset specificity and interdependency. Therefore, the analysis of impact of IOS should be discussed under different conditions.

There are different forces of information system to influence the coordinative activities between firms. Gallivan and Depledge [7] classified them as monitoring effect and collaborative effect. The monitoring use of IOS is to ensure trading partners will act as expected to avoid opportunism and moral hazards. While the collaborative use of IOS is contributed to facilitate knowledge transfer and information share among partners. Based on such category of effect of IOS, we establish our analytical framework below.

When analyzing the impact of IOS use on interorganizational coordination cost, it must be realized that investments on IOS should enhance the level of total asset specificity [12][16]. Because IOS is built with interface and information exchange procedure which is proprietary to a particular group of firms, therefore, firms wishing to join the network often need to invest in the special hardware and software for the system. Besides, any trading partner should put into effort to train its personnel to operate such system which is perhaps unique to others [13]. Support for this argument has been provided by Nidumolu [15]. His findings manifest that specific investments of IOS will bring about great switching costs among firms involved in a buyer-seller relationship. The result leads to increasing bargaining power for the firm initiating the IOS which is against other business partners' favor.

According to TCA, when organization is confronted with external uncertainty, the introduction of interorganizational relationships may conflict with the safeguarding problem incurred by substantial investments in specific assets [4]. Consequently, under conditions of substantial asset specificity, IOS may be used to monitor and control over other party's behavior to avoid them taking advantage upon the situation or exercising opportunistic behavior. Therefore, gains by use of IOS are predicted to be much more dominant than the negative influence of additional asset specificity added by the investment of IOS.

On the other conditions of low asset specificity, analysis of impact from IOS using is somewhat complexity. In accordance with TCA, low asset specificity induces no substantial safeguarding problem and interorganizational coordination is an appropriate adaptation response to environmental uncertainty. As a result, IOS is introduced to facilitate the coordination among business partners. However, under this circumstance, using of IOS may bring about great risks to both initiators and participants of systems. On the one hand, investment on system should increase asset specificity of initiators which means that they

are facing a risk to suffer from the anticipated opportunistic behavior of other organizations. While for participants, owing to have no control on the operation over system, they would be locked-in by this system and might face the possibility to be impropriated by the initiators. Therefore, to alleviate the conflict originated from IOS, all the organizations should put into more efforts to coordinate with each other to achieve their common interests. Based on this reasoning, we hypothesis:

H1: Under conditions of high asset specificity, the association between investment in IOS and interorganizational coordination costs is negative.

H2: Under conditions of low asset specificity, there is a positive association between investment in IOS and coordination costs among trading partners.

Our hypothesized relationships between IOS use and interorganizational coordination costs are summarized in figure 2.

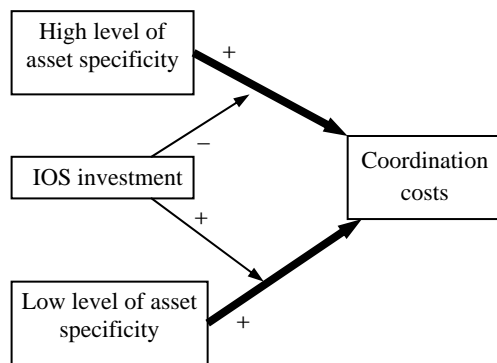


FIGURE 2: Impact of IOS use on coordination cost under different level of asset specificity

IV. A Case Study of Manufacturing Firm in China

To examine our research analysis, firstly we make a survey to investigate the using of IOS in Chinese manufacturing industry. Under the pressure of global competence, more and more firms have formed IOS-based inter-firm relationships to achieve competitive advantage. Our survey shows that more than 70% of firms have participated in certain kind of interorganizational system with their business partners. Most informants recognize they are motivated by the potential ability of systems to access greater quantity of better quality information. Nevertheless, they have different opinions on the decreasing effect of coordination cost by virtue of IOS. To illustrate our analytic method, here we select a firm located at Xiamen, a coastal city of China, for case study.

Amoi Electronic Corporation is a multinational electronic enterprise, which highly focuses on developing

and manufacturing products from telecommunication, digital video and audio to IT industry. Nowadays Amoi has become an internationally well-known leading manufacturer and supplier of mobile phones in China. In 2003, this firm has employed about 20,000 persons and the total sales reached 850 millions US dollar.

This firm has established its own interorganizational information system which has designed interface with its intra-organizational information systems. Participants of this IOS include Amoi's primary suppliers and distributors. For instance, Tianma Microelectronics Corporation (TMC) is an important supplier who provides mobile phone used liquid crystal display (LCD) for Amoi.

Since its business partners are mostly located in other cities all over China, managers of Amoi claim the operation of IOS has a crucial role on reducing communication costs and saving time of transaction. Nevertheless, considering the ability of reducing total interorganizational coordination costs by IOS, the situation is somewhat complexity according to different trading partners.

When considering its supplier, Amoi recognizes TMC as one of its most important business partners. The reason is that mobile phone is Amoi's most profitable kind of production and cutting costs is just the fundamental aspect to win competent advantage over drastic telecommunication product market. Another reason is that the supply of screen for mobile phone demands high degree of customization. Therefore, Amoi has spent a huge time, labors and capital to certify and adapt its designing and manufacturing processes for selected LCD. That means Amoi has invested high level of specific asset with TMC. If the supplier has any changes on R&D or output of LCD, and if Amoi cannot collect such information in time, that would bring about enormous damage to the producing arrangement of Amoi. To avoid contingency happening, or even being misappropriated, Amoi uses IOS to monitor this supplier's plan of R&D and throughput. On the side of TMC, it also benefit from using of this system. Because they can get the right demands from Amoi beforehand, that would be useful for them to arrange their manufacturing program. As a result, managers of Amoi acknowledge that they have experienced savings of coordination cost with TMC through IOS.

As for relationships with its distributors, both Amoi and distributors have no need to invest substantial specific asset to hold the bilateral cooperative relationships. Under such circumstance, Amoi faces a dilemma situation. On one hand, Amoi depends on distributors to occupy market. So this information system can assist Amoi to monitor sale activities of distributors' in time. On the other hand, distributors sell not only products of Amoi, but also the same kind products of others. Therefore, all the two parties have some extent of doubt. Amoi has a worry about secret leakage when using this system. And from distributors' perspective, they want to keep control of their business and remain independent from manufacturer. This leads to low level of interdependent relationships among them. Consequently, managers of Amoi claim that they cannot perceive significant reduction of

coordination cost with distributors from using of IOS.

V. Conclusion and Future Research

It is pervasively believed that interorganizational systems can play an important role in coordinating activities between organizations. Accordingly, it is reasonable to expect that the adoption of IOS can enable organization to use the information processing capabilities to reduce coordination costs and improve performance. However, the past researches show mixed results about the impact of IOS on the coordination costs. Some researches provide favorable evidences to this suggestion [10][14], while other results give no significant support to it [3][13]. This paper focuses on the possible conditions under which IOS use can positively affect coordination of activities between firms.

According to transaction cost analysis, under external uncertainty environment, asset specificity becomes the primary issues to influence coordinative patterns between business partners. From the perspective of technology, IOS may be used as a collaborative platform to share knowledge and facilitate knowledge transfer between firms [7]. Moreover, organizations usually use IOS as a control mechanism to monitor the business partners. In general, the monitoring use of information system is applied to alleviate risks induced by investment on specific asset, while the cooperative use of information system is to strengthen bilateral cooperative relationships. On the other hand, investment on system should increase asset specificity of initiators which means that they are facing a risk to suffer from the anticipated opportunistic behavior of other organizations.

This paper discusses impact of IOS use on interorganizational cost under two situations of asset specificity. If a high level of asset specificity exists, organizations have to put more coordinative efforts to maintain the cooperative relationships. Upon that, gains by use of IOS are predicted to be much more dominant than the negative influence of additional asset specificity added by the investment of IOS. However, on the conditions of low asset specificity, investment on system should increase asset specificity. As a result, IOS use has a potential to increase interorganizational coordination cost.

At last, a case study is presented here to investigate IOS use in manufacturing industry from China in accordance with our framework. The findings from the case study demonstrate researching direction of our method.

Though the findings of this study provide valuable insights, there are still a lot of works need for further research. For instance, considering the shortage of case study method, it is essential to require quantitatively methods examining large number of IOS use from a wide

extent. Second, because of diversified goals, abundant development and operation of IOS, association of information technology use and coordination cost under economic conditions needs to be examined in a much broader context incorporating more types of IOS.

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Consumers' Adoption of B2C E-Commerce in Macao

Chang Boon Patrick LEE *, Chun Yip Desmond YUEN **, Sze Kin Ken LEE***

Faculty of Business Administration, University of Macau

* cblee@umac.mo ** desmond@umac.mo *** kenlee7948@yahoo.com.hk

Abstract: This research sets out to determine factors that influence consumers' adoption of B2C E-commerce in Macao. While prior research has shown that there are many factors that influence E-commerce adoption, this research hypothesized that two variables – namely, trust and willingness to use credit cards for online transactions – influence E-commerce adoption in Macao. This research further hypothesized that trust and willingness to use credit card interact to influence adoption. Using data collected from a questionnaire survey, the results of this study found that the two hypothesized variables are positively related to intention to adopt E-commerce. The results also support the interaction effect. The nature of interaction showed that trust is related to E-commerce adoption only when willingness to use credit card for online transaction is high. Also, willingness to use credit card for online transaction is related to E-commerce adoption only when the level of trust is high. These results provide a richer understanding of the relationship between the hypothesized variables and E-commerce adoption. This study also collected interview data related to Internet users' adoption of E-commerce. The interview data provide a better understanding on why Macao people are afraid of using credit card for online transactions. The researchers gathered more information about interviewees' credit card usage and habits, their attitudes toward credit card security, and their thoughts regarding identity theft. The interviews also uncovered other factors that may influence E-commerce adoption.

Keywords: E-Commerce Management; E-Commerce adoption.

I. Introduction

The internet has played an increasingly important role in people's daily life. One important feature provided by the Internet is that it creates an innovative channel called the electronic commerce that enables people to do business through the network. E-commerce is currently revolutionizing the way people work. Many commercial establishments as well as researchers are keen to determine the factors that influence people to engage in E-commerce. Although numerous studies have been conducted, they were carried out mostly in a western setting. Few studies exist on E-commerce in less developed places, such as Macao, a special administrative region of China. The researchers, being residents in Macao, are interested to determine the

factors that influence consumers' adoption of E-commerce in Macao.

There are few statistics on the popularity of E-commerce in Macao. A study by Cheung and Wang (2004) has found that about 57 percent of household in Macau has Internet connections. This figure suggests a potential pool of E-commerce users exists. This study, therefore, focused on B2C E-commerce in Macao and it sought to determine the factors that influence consumers' adoption.

A literature review on EC adoption has found that trust is a variable that is extensively emphasized in prior research. Even though the literature stressed the importance of trust in E-commerce, empirical research has found there was only a small variance between trust and adoption of E-commerce. Bhattacharjee (2002) has pointed out that trust explained only 13 percent of the users' willingness to transact online. This result is surprising. No explanations have been provided for the low variance. One motivation for this research, therefore, arises from the curiosity to further examine this relationship.

Given that the context of this research is in Macao, the researchers are interested to know if consumers' willingness to use credit card for online transactions would affect adoption of E-commerce. In Macao, credit card facilities are reasonably accessible from financial institutions. People in Macao, however, may not be easily persuaded to use credit cards online because of some inherent fear they have regarding its usage. The willingness to use credit card for Internet transactions, therefore, is chosen as a variable that warrants closer attention in this research.

This study develops and tests a model that determines the factors that underlie people's adoption of E-commerce in Macao. Specifically, this study hypothesizes and tests the relationship of two independent variables that influence the adoption of E-commerce. The two independent variables are perception of trust in E-commerce and willingness to use credit card in electronic transactions. The dependent variable is the adoption of E-commerce. Besides linear relationships between the independent and dependent variables, this research also tests the presence of an interaction effect created by the two independent variables. Prior research has not examined or explored the interaction effect.

It should be noted that even though there may be many factors that could influence the adoption of E-commerce, this research has chosen to focus on two salient variables – namely, trust and willing to use credit card for online transactions. Technical dimensions of E-commerce are not included in this research.

II. Factors influencing usage of E-commerce

Chang et al. (2004) have done a thorough review of the literature on factors that influence usage of B2C E-commerce. Their review found that many variables influence usage. They include security, risk, trust, willingness to use credit card in electronic transactions and others. The following sections review these variables.

II.1 Security in E-commerce

Internet security is very important to E-commerce users. As the internet is a public network, it is possible for hackers to steal passwords and personal information. Hackers can also impersonate users and perform illegal transactions over the internet. For example, there are hackers who use other people's name and password to perform illegal financial transactions to obtain money or goods.

Although academics and industry have known about the security problems (Bhatnagar et al., 2000; Suh and Han, 2003), these problems have been accommodated rather than corrected. As a result, there have been more and more cases of wide-scale security infractions throughout the network over the last few years. For example, there have been reports that credit card information has been stolen due to breaches in security (Bergstein, 2005).

II.2 Risk in E-commerce

E-commerce users need to take more risks compared to traditional commerce users (Martinsons, 2002). For example, E-commerce users may receive services or products that are below their expectations and they have minimal recourse because the legal protection for E-commerce users varies from country to country. Web retailers may also take advantage of the distant and impersonal characteristic of E-commerce to mislead consumers (Pavlou, 2003). Some of the risks that E-commerce users face include economic risk (lost of money), personal risk (safety of the goods or services), seller performance risk (careless control of the buying process) and privacy risk (revealing consumers' private information).

II.3 Trust in E-commerce

Rotter (1971) has pointed out that trust is the expectation that commitments undertaken by another person or organization will be fulfilled. Trust also involves a person's willingness to be vulnerable to the actions of another person or people (Mayer et al., 1995). That is, the parties will protect the right of the other party involved. Trust is very important in many social and business activities.

Suh and Han (2003) have pointed out that trust is important because there are uncertainties and risks involved in E-commerce. Gefen (2002) has also emphasized the importance of trust in E-commerce because of the less verifiable and less controllable business environment in the Internet. Kim and Prabhakar (2004) argued that consumers'

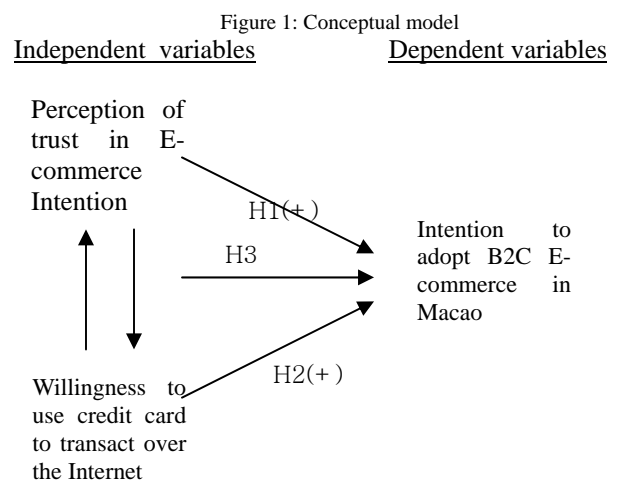
lack of trust in the electronic channel is a possible reason for the delayed acceptance of the Internet as a retail distribution channel. Indeed, prior studies have found that there is a significant positive impact on overall trust affecting people's usage of online shopping. (Bhattacharjee, 2002; Gefen, 2000; Gefen et al., 2003; Yoon, 2002).

II.4 Willingness to use credit card in E-commerce

Suh and Han (2003) pointed out that even though the number of Internet users has increased dramatically, many are not willing to use credit card over the internet because people do not have confidence in E-commerce security. Based on volume, credit cards and charge cards were the most common payment methods used in the U.S. (Sienkiewicz and Bochicchio, 2002). In some countries outside of America, using credit card for online transactions may not be popular. Many Internet users are afraid of security issues when they send credit card information over the Internet. When their personal information is sent through the Internet, they are exposed to hackers who may be able to intercept their information.

III. Hypothesis development

In this study, the researchers selected two of the more compelling variables that may impact E-commerce adoption in Macao. The intention is to develop a parsimonious model. Figure 1 shows the model. As shown in the figure, the dependent variable is the intention to adopt E-commerce. The two independent variables are (i) the perception of trust in electronic transactions and (ii) willingness to use credit card in electronic transactions. The following paragraphs describe the variables as well as the hypotheses developed for the research.



- Intention to adopt E-commerce in Macao

Intention to adopt E-commerce is used as a proxy for adoption of E-commerce. Longitudinal data are required to measure adoption of E-commerce. As this study used cross

sectional data, intention to adopt E-commerce is used as a proxy. According to prior research, intention is the best predictor of behaviour (Ajzen, and Fishbein, 1980). Prior research has used intention to adopt E-commerce as a proxy for E-commerce adoption (Cao and Mokhtarian, 2005).

● Perception of trust in electronic transaction

Traditional commerce is the main channel for doing business in Macao. Macao has a small geographic area of about 26 square kilometres. Shopping for most products and services is easy and convenient. Furthermore, Hong Kong, which is considered a shopping paradise, is just an hour's ferry ride away. People will avoid using E-commerce unless they have trust in it. Macao is a Chinese and Portuguese society. If people want to buy things from foreign countries' websites, the buyers frequently need to have good knowledge of English in order to complete the transaction. When people want to use electronic transaction and they do not have a clear understanding of the terms and conditions, they become vulnerable. Trust, therefore, plays a very important part in E-commerce. Even though prior research had shown that there is a positive relationship between trust and E-commerce adoption, this study seeks to affirm that the relationship holds true in the Macao business environment. Hypothesis 1, therefore, is as follows:

H (1): When people have a higher perception of trust in E-commerce, their intention to adopt E-commerce will be higher.

● Willingness to use credit card in E-commerce

Most E-commerce transactions are carried out using credit cards. When people use credit card in E-commerce, they need to provide their credit card number and personal information to the other party. After the other party receives the money from the buyer's credit card account, the goods or services will be delivered to the buyer. It is simple and convenient to use credit card payment in E-commerce transactions. Some people feel, however, it may not be safe to transmit credit card information over the Internet because the Internet is a public network and as such, information provided in the transaction may be stolen. Also people fear that information related to the E-Commerce transactions may be abused.

Human nature is such that we always need a sense of security. We need to protect our personal information. E-commerce is still a new mode of doing business compared to traditional commerce. People need to bear certain risk when using the credit card for E-commerce transactions. Their personal data may be stolen. For these reasons, people may hesitate when they shop online. Hence the following hypothesis:

H (2): When people have a higher willingness of using credit card in E-commerce, their intention to adopt E-commerce will be higher.

● Interaction effect

As mentioned previously, prior empirical research has found only a small variance between trust and adoption of E-commerce. This is surprising, given that trust has been emphasized extensively in the literature. It is possible that trust interacts with another variable to influence E-commerce adoption. Figure 2 shows it is possible that when there is low willingness to use credit card for electronic transactions, trust does not have any relationship with intention to adopt E-commerce. Similarly, figure 3 shows that when there is low trust in E-commerce, willingness to use credit card does not have any relationship with intention to adopt E-commerce.

Based on the hypothesized interactive effect, a set of topology is proposed for the various groups of E-commerce adopters. Figure 4 shows the topology. The figure shows that people with low trust in E-commerce and low willingness to use credit card in E-commerce are classified as non-adopters. People with high trust in E-commerce and low willingness to use credit card in E-commerce are classified as ready but afraid category. People with low trust in E-commerce and high willingness to use credit card in E-commerce are classified as not ready but willing category. People with high trust in E-commerce and high willingness to use credit card in E-commerce are classified as adopters.

Figure 2: Trust and adoption of E-commerce

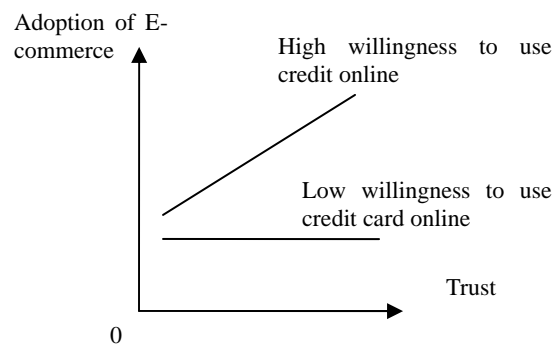


Figure 3: Willingness to use credit card and adoption of E-commerce

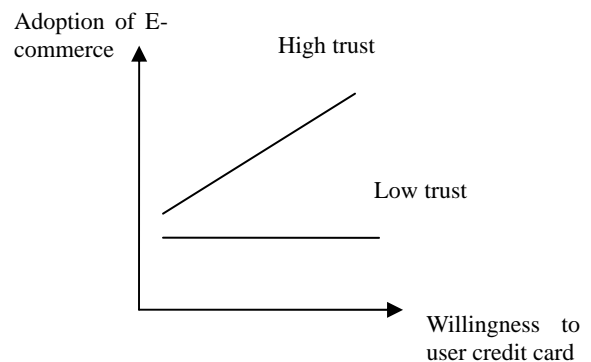
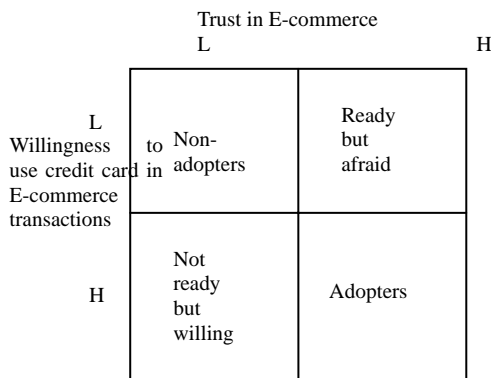


Figure 4: Topology of E-commerce adopters



Based on the above discussion, the following hypothesis is developed for this study:

H(3): Trust and willingness to use credit card interact to influence intention to adopt E-commerce.

III. 1 Research method

Quantitative and qualitative approaches were used to conduct the study. The following sections discuss these approaches.

III. 2 Quantitative approach

The quantitative aspect of this research made use of data that have been collected from a E-commerce questionnaire survey. The respondents for the survey were Internet and E-commerce users in Macao. The questionnaires were distributed to 250 Internet and E-commerce users. They comprised colleagues, office workers, and postgraduate students studying at the University of Macao. Respondents participated in the questionnaire survey voluntarily. The respondents were assured that the information gathered in the survey will be kept confidential. The questionnaire did not require respondents to identify themselves.

The questionnaire items were in English. As most respondents read Chinese, a Chinese translation was provided. To minimize translation errors, the draft Chinese version of the questionnaire was translated back to the English version to ensure translation errors were minimized.

From the data collected, the researcher made use of data for two global measures. They were (i) perception of trust in electronic transaction and (ii) willingness to use credit card in electronic transactions. Data for two items measuring intention to adopt E-commerce were also used in this research. All measures used in the research are shown in Table I. The data were based on a seven-point Likert-type scale.

Demographic data were also collected during the survey. These include gender, age, occupation, income, education level, experience using the Internet, and online habits of the respondents. The software named SPSS (Statistical Package for Social Science) version 12 was used for data

analysis. Moderated multiple regression was used to analyse the data.

Table I: Measurement

Measurement items *	Variables to be measured
a. I am not willing to use my credit card in online transactions	Willingness to use credit card in electronic transaction
b. E-commerce is not trustworthy	Perception of trust in electronic transaction
c. I will try my best to avoid using E-commerce	Intention to adopt E-commerce
d. In the coming future, I would not use E-commerce	Intention to adopt E-commerce

* items were reverse coded.

III. 3 Qualitative approach

This study also conducted semi-structured interviews to collect qualitative data. The purpose of the interviews was to obtain a richer understanding about B2C E-commerce adoption in Macao. Specifically, the interviews were motivated because it is possible that there are some underlying reasons for the Internet users' perceptions regarding trust in E-commerce and their willingness to use credit card for online transactions. The interviewees were chosen based on the researchers' contacts. The interviews were conducted in company premises such as meeting rooms or at a quiet place where the interviews were free from disturbances. The third author conducted separate interviews for seven interviewees. Each interview lasted about 20 minutes. A set of questions was prepared to guide the interviews. Before the interviews, the researcher asked permission to record the interviews. The interview data were then transcribed and analyzed.

IV Data analyses

To analyze the data collected, the survey responses were first coded and input into the SPSS data sheet. The following sections describe the survey respondents and the results of analyses for the survey data. They also describe the analyses of qualitative data.

IV. 1 Descriptive statistics for survey data

Among the 250 questionnaires distributed, 178 were answered completely. Thirty four were incomplete and 38 did not return the questionnaires. The response rate, therefore, was 71.2%. Table II shows the demographic characteristics of the survey respondents. The table shows that majority of the respondents are between 21 to 30 years of age. Their educational level was mostly college and above and they had more than 5 years experience in using the Internet. About 67% spent between 28 to 42 hours online per week.

Table III shows the descriptive statistics. As shown in the

table, the mean score for the three variables in the table are below 4. Given that the scale for measuring the variables ranges from 1 to 7, where 1 represents “strongly disagree” and 7 represents “strongly agree” with the statement presented, and 4 is the neutral value, the mean score shows that respondents generally have low trust for electronic transactions, low willingness to use credit card in electronic transactions, and low intention to adopt B2C E-commerce.

The Pearson Correlations in Table III show that the two independent variables – perception of trust in electronic transaction and willingness to use credit card in electronic transaction – are positively correlated to intention to adopt E-commerce. There is also a positive correlation between willingness to use credit card in electronic transaction and perception of trust in electronic transactions.

IV. 2 Hypotheses testing

The hypotheses were tested using regression analyses. The tests used three regression models. Each model corresponds to the hypothesis to be tested. For example, Model 1 has one independent variable and one dependent variable. The independent variable is the perception of trust in electronic transaction and the dependent variable is the intention to adopt E-commerce. After Model 1 has been tested, a second independent variable – which is the willingness to use credit card in electronic transactions – is added to the regression. Model 2, therefore, comprises two independent variables and one dependent variable. Hypothesis 2 is tested using Model 2. After testing Model 2, an interaction variable – which is created by the multiplication of the first two independent variables based on their centered scores – is added into the regression model. The new model, which is model 3, is used to test hypothesis 3.

Table II: Demographic characteristics of respondents (N=178)

		Freq	Percentage
Gender	Male	102	57.3
	Female	76	42.7
Age	21-30	128	71.9
	31-40	50	28.1
Occupation	Student	14	7.9
	Employee	123	69.1
	Official	9	5.1
	Businessman	10	5.6
	Others	22	12.4
Monthly Income	Below \$5,000	8	4.5
	\$5,000-\$8,000	66	37.1
	\$8,001-\$12,000	39	21.9
	\$12,001-\$20,000	58	32.6
	\$20,000 or above	7	3.9
Education level	Secondary	17	9.6
	College or above	161	90.4

	above		
Experience in using Internet	3 years to 5 years	17	9.6
	Above 5 years	161	90.4
Online habit	14 to 28 hours	49	27.5
	28 to 42 hours	119	66.9
	Above 42 hours	10	5.6

Table III: Descriptive Statistics

Variables	N	Mean	Std Dev	Correlations*	
				T	W
Perception of trust in electronic transaction (T)	178	2.97	1.61	-	-
Willingness to use credit card in electronic transaction (W)	178	3.41	2.09	0.456	-
Intention to adopt E-commerce (A)	178	3.35	1.16	0.418	0.363

*All correlations are significant at $p < 0.01$

Table IV summarizes the results of regression analyses. The table shows that in Model 1, the beta for the independent variable is positive and significant. Hence, hypothesis 1, which states that when people have a higher perception of trust in E-commerce, the more they will adopt the use of E-commerce, is supported.

Table IV also indicates that there is a significant increase in R-squared when Model 1 progressed to Model 2. The increase indicates that the addition of the second independent variable – willingness to use credit card in online transactions – provides additional explanatory power to the regression model. Note that the betas for the two independent variables are significant. Hence, hypothesis 2, which states that when people have a higher willingness of using credit card in E-commerce, the more people will adopt the use of E-commerce, is supported.

Table IV: Results of regression analyses

Variables in model	Model 1	Model 2	Model 3
Constant	2.456**	2.256**	2.357**
Perception of trust	0.302**	0.230**	0.188**
Willingness to use credit card	-	0.121**	0.106**
W x T	-	-	0.163**
R ²	0.175	0.212	0.236
Change in R ²	-	0.037**	0.024**

** $p < 0.01$

The centered scores of the two independent variables were used to calculate the interaction term in model 3. This was done to mitigate the problems of multicollinearity (Aiken and West, 1991). The results of the regression analyses show that there is a significant increase in R-squared when the interaction variable is added to Model 2. This result indicates that the interaction variable provided significant explanatory power to Model 3. Note that the coefficient of the interaction variable is significant. The value of the VIF for the interaction term is 1.239, which is within the limit that indicates multicollinearity is not a concern. The results, therefore, supports hypothesis 3, which states that trust and willingness to use credit card interact to influence usage of E-commerce.

Given that there is a significant interaction effect, the researcher proceeded to examine the nature of the interaction effect. First, the researcher divided the respondents into two groups – those with low and high willingness to use credit card in electronic transactions. Respondents who have W less than or equal to 3 were grouped as people who have low willingness to use credit card in electronic transaction. There are 108 respondents in this group. Respondents with W greater than or equal to 5 were grouped as having high willingness to use credit card in electronic transactions. There are 53 respondents in this group. Regression analyses were carried out to determine how trust and intention to adopt E-commerce relate to each other in these two groups.

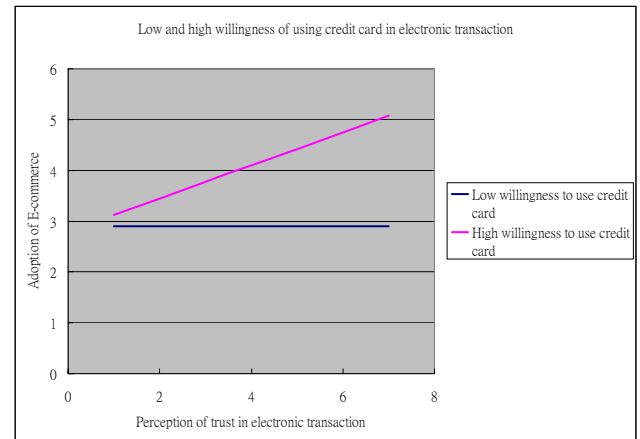
Table V summarizes the results of the regression for the groups with low and high willingness to use credit cards for online transactions. Figure 5 provides a graphical representation of the results shown in Table V. The graph in Figure 5 shows that when people have low willingness to use credit card in electronic transactions, the level of trust is not related to intention to adopt E-commerce. This is unlike the case when there is high willingness to use credit card in electronic transactions. In this case, the level of trust is positively related to intention to adopt E-commerce.

Table V: Regression analysis of low and high willingness to use credit cards

Variables in model	Low willingness to use credit card	High willingness to use credit card
Constant	2.905**	2.798**
Perception of trust in electronic transaction (T)	0.072	0.325**
R2	0.009	0.278

** p<0.01

Figure 5: Graphical representation of low and high willingness to use credit cards



The study also divided the respondents into those with low and high perception of trust in electronic transactions. For respondents with T less than or equal to 3, they are grouped as people who have low perception of trust in electronic transaction. For respondents who have T greater than or equal to 5, they are grouped as having high perception of trust in electronic transaction.

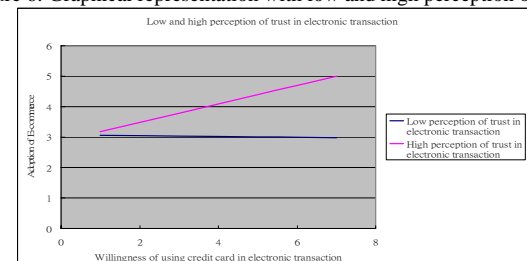
Table VI summarizes the results of the regression for the groups with low and high trust in E-commerce. Figure 6 provides a graphical representation of the results shown in Table VI. The graph in Figure 6 shows that when people have low trust in E-commerce, the level of willingness to use credit card for electronic transactions is not related to intention to adopt E-commerce. This is unlike the case when there is high trust in E-commerce. When there is high trust, the willingness to use credit card for E-commerce transaction is positively related to intention to adopt E-commerce.

Table VI: Regression analysis with low and high perception of trust

Variables in model	Low Trust in E-commerce	High trust in E-commerce
Constant	3.075**	2.880**
Willingness to use credit card in electronic transaction	-0.014	0.303**
R2	0.000	0.360

** p<0.01

Figure 6: Graphical representation with low and high perception of trust



IV. 3 Results of qualitative analysis

This study conducted separate interviews with 7 Internet users. The interviewees unanimously agreed that trust is "very important" in E-commerce. The interviewees said that in E-commerce, trading is performed without the physical interaction between the trading parties. Consumers, therefore, must trust each other completely when they are involved in E-commerce.

With regards to credit cards, the interviews found that they are very popular with the interviewees. The interviewees, however, used their cards mostly offline. Not many used their cards online. They felt that there is a difference in using credit cards online and offline. One interviewee, who used her credit "10 to 20 times a month" used her credit card for online transactions only twice. She said, "When I used it (credit card) online, it makes me a bit worried." Another interviewee said she used her card "several times a month", but she had not used her card for E-commerce. She went on to say, "The law protection for E-commerce is not enough in Macao. ... I think E-commerce is too new in Macao. ... At this time, I think I will not use E-commerce unless it has a great improvement on protection to the user." Another interviewee shared the same feeling. She said the reason she was not willing to use her credit card online was because she thought that the security for E-commerce is not mature.

Despite the interviewees' worries about using credit cards online, they generally think that E-commerce is advantageous because it is convenient. They think that western countries are large and people there cannot buy things easily. Westerners, therefore, are more willing to use credit card to do online transactions. Some interviewees felt that there was no need to use E-commerce in Macao because Macao is a small place and people can buy things easily.

The interviewees felt that they have no choice but to use credit card as the payment method if they decide to use E-commerce. Some interviewees said that digital signature can help to improve security. Another interviewee suggested that government can set up a central clearing house for every E-commerce transaction.

Besides trust and willingness to use credit card online, some interviewees have alluded that factors such as price, uniqueness and convenience are factors that may influence people to use E-commerce. People will choose E-commerce when it can offer a lower price than traditional commerce. Uniqueness will attract people to use E-commerce because people will use E-commerce once they cannot find the products they want in traditional commerce. According to the interviewees, people may only use E-commerce as a substitute to traditional commerce.

A number of interviewees also said that it is easy to disguise one's identity over the Internet, even though it required some technical skills to avoid being detected by others. Most of the interviewees agreed, however, it is difficult to detect identity theft. Due to the fear of identity

theft, many interviewees ended up not using E-commerce.

V Discussion and Conclusion

This study has obtained three significant sets of results. The first showed that Internet users in Macao generally have low trust in E-commerce, low willingness to use credit card for E-commerce transactions, and low intention to adopt E-Commerce. The second showed that Internet users' perception of trust in electronic transaction and their willingness to use credit card in electronic transactions are both positively related to intention to adopt E-commerce. These relationships are consistent with those found in prior research. The third set of results showed that there exists an interaction effect between trust in electronic transaction and willingness to use credit card in electronic transaction on intention to adopt E-commerce. This interaction effect provides a significant contribution to knowledge as it helps to shed light on why prior research has found only a small variance between trust and adoption of E-commerce. Prior research could have obtained a higher explanatory power on the relationship between trust and adoption of E-commerce if it had taken into consideration the willingness to use credit card in E-commerce transactions.

V. 1 Managerial implications

The results obtained from this study suggest a few areas the Macao E-commerce industry should focus in order to expand the industry. First, the results showed that trust is very important. To increase adoption of E-commerce, it is important that customers be provided with a trustworthy environment. Among the many ways that might help to develop trust, E-commerce companies should consider upgrading their computer hardware and software so that with the advantage of new technologies, the companies can increase the security of the transaction environment. It will make more people trust E-commerce once the environment becomes more secure. Trust may also be developed through other means such as building a good reputation or having a good company image. Companies should think of ways that can help to develop their reputation and image so that there will be more E-commerce customers.

The results obtained from this research also imply that willingness to use credit card in electronic transaction could influence adoption of E-commerce positively. It is important, therefore, to increase willingness to use credit card in electronic transaction. Most of the Internet users interviewed said they were reluctant to use credit card over the Internet because of their concern regarding security of the Internet. It is important, therefore, to address this issue. The industry should consider using newer technologies to innovate and improve on internet security. The industry should also develop payment methods to complement or substitute credit card payment. While credit card is currently the primary method used for payment in E-commerce transactions, other methods of payment could also be developed.

V.2 Limitations

The results obtained from this research are subject to a number of limitations. First, the results should be interpreted in the context of the research setting. The research was carried out in Macao, and as such, the results are applicable only to E-commerce in Macao. The results may not be generalizable to E-commerce in other countries. Second, the selection of respondents and interviewees for this research was based mostly on the researchers' contacts. Most participants were from similar sectors of the society, that is, they are mostly white-collar workers. Nevertheless, the researcher has found that the demographic characteristics (in terms of age and educational level) of the respondents in this study are similar to those of another study on the Internet users in Macao (Cheung and Wang, 2004).

VI. II Direction for future research

While this study has found that trust and willingness to use credit card for online transactions are variables that influence intention to adopt E-commerce, future research should explore other factors that may also influence E-commerce adoption among Internet users in Macao. For example, advertisements, government regulations, pricing strategies and after sales services may be possible factors that are related to consumers' adoption of E-commerce in Macao. Future studies may help to shed light on these factors. As suggested by the interviewees, future research may also focus on developing safer payment methods for E-commerce transactions.

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Understanding the Adoption of Business-To-Employee (B2e) Portals: An Experience of a Large Australian University

Md. Mahbubur Rahim*, Lyfie Sugianto, Nusrat Shameem
Clayton School of Information Technology
Faculty of Information Technology
Monash University, Victoria, Australia
Phone: 613-9905-9952, Fax:613-9905-5159
*E-mail: mahbubur.rahim@infotech.monash.edu.au

Abstract: Business-to-Employee (B2E) portals represent a customised, personalised, ever-changing mix of news, resources, applications, and e-commerce options that become the desktop destination for everyone in a business. They have the potential to improve corporate communication with employees and enhance their productivity and loyalty. Attracted by this potential, many organisations are now investing in B2E portal technologies. Little is however reported about the experience of businesses in adopting these portals. This paper presents the staff portal adoption experience of a large Australian university and reports on the findings about the motives of the university for adopting the portal, the features included in the portal, the approach used in its introduction and the key factors that influenced the decision of the university to invest in it. The findings identified an important factor that was not cited in the portal literature. The implications are discussed.

Keywords: e-commerce management, portal, B2E portal, staff portal, adoption, portal adoption, Australia, case study.

I. Introduction

Today's businesses are characterised by the presence of a distributed workforce that is required to stay in touch with corporate offices and access relevant contents and applications in order to make decisions [3]. However, the dynamic business environment within which the distributed workforce functions often leads to a lack of communication, and consequently, company loyalty. To maintain communication with their employees, to encourage them to share knowledge, and to build a sense of community, businesses are challenged to develop a good delivery system for their workforce [13]. Corporate intranets which were developed by many businesses for delivering services to their dispersed employees are often fragmented and lack customisation features [2]. Fortunately, business-to-employee (B2E) portals have recently emerged that embrace e-business approaches and internet technologies and are able to provide a comprehensive set of services to employees [21]. These portals, which are also known as employee or staff portals, represent the next step beyond the current generation of corporate intranets [7]. They provide not only

corporate information tailored to the needs of employees but also useful applications for assisting them in performing their routine tasks [19] and serve as a single point of business contact with employees [15].

The use of employee portals is growing steadily. Merrill Lynch Capital Markets envisage portals to become a US\$14 billion business outnumbering the growth rates of other hot enterprise applications markets [7]. According to Banks [4], the number of organisations implementing B2E portals is also increasing in Australia. However, very little research is reported about the adoption of these portals which is not surprising given that it is an emerging technology. Moreover, academic literature had traditionally been slow to follow up the fast-moving trends of e-business in general [12]. As a result, little is known about why businesses adopt B2E portals, how they introduce these portals, what portal features are offered, and what factors influence their decisions to adopt B2E portals. This paper addresses these key research concerns by focusing on a large Australian university that has introduced a staff portal in recent years. The findings from the university are significant because they illuminate the influence of a set of success factors useful to the senior management of the potential adopter organisations intending to introduce B2E portals. The paper also contributes in building a rich empirical foundation for B2E portals.

The paper is organised as follows. First, the existing literature on the adoption of B2E portals is briefly reviewed and a preliminary model is developed explaining how key factors affect the decision of business to adopt B2E portals. Second, the research approach is described. Third, the background of the participating case organisation is presented. Fourth, empirical evidence from the case organisation relating to the research concerns is presented. Fifth, the case study findings are then discussed in the light of the existing literature and the proposed model. Finally, the contributions of the research are highlighted and areas of possible further investigations are mentioned.

II. Related B2E Portal Literature

Business Motives for B2E Portal Adoption

Generally, being motivated by the intent to gain economic benefits businesses adopt B2E portals. These portals are expected to offer customised contents and applications to employees which in turn empower them in making decisions,

improve their efficiency and enhance their satisfaction with their business [7, 11].

Features of B2E portals

A range of attractive features are included in B2E portals in order to enable the dispersed workforce to access customised services through the portal. These features can be grouped into three broad categories [5]: core capabilities, supportive capabilities and web services. Core capabilities refer to the ability of portals to create contents and inclusion of documents in many formats (called publishing), search capability to enable employees to locate relevant documents, personalisation facility allowing employees to modify their own interfaces, and on-line collaboration capabilities. Supportive capabilities include those tools that are necessary for the well-function of portals, and consist of: security to access resources and profiling aimed at sending information to employees based on data obtained from human resources department. In contrast, web services include those services that provide employees with an access to e-marketplace where a company offers employees discounts on products or services.

B2E Portal Adoption Approach

Sparse scholarly literature is available that addresses how businesses should introduce B2E portals. This view is consistent with that of Tojib et al. [20] who acknowledge that inadequate attention has been paid in the portal literature concerning the adoption approach of B2E portals. However, trade magazines provide useful suggestions concerning the introduction of employee portals in business settings. For example, Meuse [14] offers a multi-step guideline concerning the introduction of successful employee portals: a) determining employees' want, b) making content compelling, c) reviewing popular websites to determine how employee access portals, d) establishing a single point of entry, e) creating useful services, f) branding employee portals and g) choosing a competent provider. On the matter of in-house B2E portal development, Tojib et al. [20] have recently proposed a framework in which they have recommended prototyping and incremental approach as the most suitable development strategy. In addition, the use of pilot project was also emphasised.

B2E Portals Adoption: A Preliminary Model

A brief review of the existing B2E portal literature indicates a sheer lack of studies investigating the factors affecting the adoption initiatives of portals. Hence, the information technology and e-business literature was consulted to develop a preliminary model (shown in Figure 1) that includes the following most frequently cited factors: (a) management support, (b) IT expertise, (c) complexity with B2E portals, (d) cost of introducing B2E portals, and (e) vendor pressure. A brief justification for including these factors is provided below.

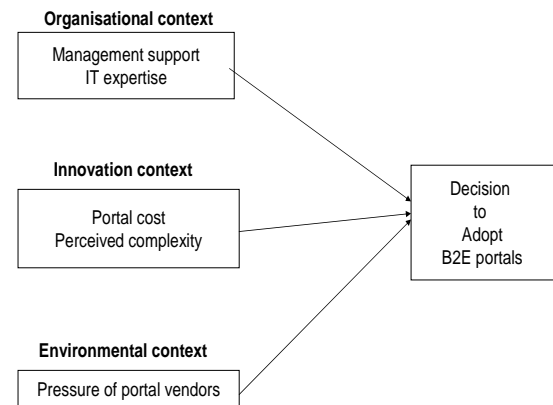


Figure 1: A conceptual model of B2E portal adoption

Management support refers to not only the articulation and symbolic championing of a new undertaking by the senior management but also the commitment of resources [16]. Many studies in IT have shown that management support is absolutely necessary for successfully adopting an innovative application [17, 18]. In the context of B2E portals, it is important to secure commitment from senior management because employees represent a key asset for the survival and progress of business. Management must recognise that availability of on-line resources through portals has the ability to significantly improve the performance of employees. The integration of on-line resources with portals however requires considerable investment which cannot be obtained without strong management support. Moreover, training, which helps the smooth completion of B2E portals on schedule involves financial commitment for which management commitment is further necessary. Hence, the following proposition is suggested:

P1: Management support is positively related to B2E portals adoption decisions

A lack of technical knowledge has long been identified as an important factor that may negatively affect the introduction of an IT project [9]. Unlike many other IT applications, B2E portal projects are more complex due to the need for establishing seamless integration with many other applications (that may possibly run on different platforms). Therefore, adequate IT expertise must be available before deciding to introduce B2E portals. Considerable expertise is also needed for building a B2E portal from scratch. Moreover, when B2E portals are acquired from external vendors, expertise must be available on how to tailor the product to suite the needs of business. Therefore, an organisation is likely to adopt B2E portal when it has relevant IT expertise. Hence, the following

proposition is suggested:

P2: The IT expertise of organisations is positively related to B2E portals adoption decisions

Cost is an important factor for any IT application and is usually assumed to negatively affect the adoption of the application [8]. This view is supported by Benbya [5] who argued cost effectiveness of portals as a major factor affecting its adoption by organisations. In relation to B2E portals, costs include hardware costs, software license costs, software development costs, design costs, system integration costs and maintenance. Such costs play even a greater role because commercially available portal products are very expensive which quite often run into millions. This is supported by Gartner group which estimated that portals featuring full workplace integration would cost between US\$1 million to US\$3 million [1]. Therefore, the following proposition is developed:

P3: The perceived cost is negatively related to B2E portals adoption decisions

Complexity generally refers to whether a technology is difficult to understand and use [6]. In the context of B2E portals, it is argued that complexity is likely to be greater than other forms of IT-systems because of the need to integrate portals with disparate application systems that exist in organisations. The perceived complexity may thus deter the introduction of B2E portals in organisations. Hence, the following proposition is suggested:

P4: The perceived complexity is negatively related to B2E portals adoption decisions

Today's organisations, of all sizes, operate in a highly dynamic business environment which is characterised by pressure arising from influential external bodies. The adoption of B2E portals by rival organisations may encourage businesses to adopt these systems to remain competitive. Furthermore, IT vendors position portals as a compelling way of integrating business processes that spans across multiple applications [2]. Hence, driven largely by vendor hype and promises, businesses are also likely to introduce B2E portal solutions. As such, the following proposition is suggested:

P5: The perceived vendor pressure is positively related to the B2E adoption decisions.

III. Research Approach

B2E portal adoption is a contemporary phenomenon which needs to be examined in its natural settings. Moreover, the complex interplay of actions between academic and administrative staff and the distribution of power among different faculties and administrative units within an university environment are also likely to increase the complexity of B2E portal adoption. Hence, it is critical to capture the experiences of the relevant people and the

context of their actions to understand B2E portal adoption practice. As such, a case study approach which is suitable for understanding phenomena within their organisational context was chosen [22]. A large university was selected as a revelatory case site because it successfully introduced staff portals in recent years and was willing to share its rich experience with the researchers. In-depth interviews were sought from three senior executives: head of the IT function, IT applications manager and a senior manager responsible for flexible learning and teaching (FLT) environment. The interviewees granted access to university reports relating to the introduction and structure of staff portals, flexible learning and teaching environment, and conference papers that they had presented on staff portals. This helped the researchers to corroborate the information provided during the interviews. The interviews were tape recorded which were subsequently transcribed and were sent to the interviewees for review. Data collected from the interviews were analysed using the pattern matching logic [22].

IV. Description of Case

The participating case is a large university located in a capital city, Australia. It has more than 50,000 students from over 100 countries and 5000 staff who are spread over several campuses. The university is recognised for its excellence in teaching, learning, research and graduate outcomes. In the year, 2004 the university had a revenue of about A\$800 millions. Its IT department consists of about 100 employees and has employed a wide range of IT enabled applications in support of major business processes supporting the core functionalities of the university.

V. Case Study Findings

This section presents empirical findings concerning: a) the motives of the university for adopting staff portal, b) the features and services offered by the portal, c) the portal development approach, and d) the factors that had an effect on the university's decision to adopt staff portals.

Staff Portal Adoption Motives

The motivation to adopt portals was conceived internally. In the year 1997, the senior management of the participating university recognised that its teaching practices require significant changes in order to retain and expand its current market. Consequently, a university-wide master plan was developed in the year 1998 that provided a new direction for the university. As a part of the master plan, the 'Flexible Learning and Teaching Plan' was released that suggested the university to embark on a program to deliver a student-centered flexible learning and teaching practices based on a suitable IT infrastructure. More specifically, the plan identified the need for a homogeneous and integrated IT-enabled environment to allow staff and students alike to access and manage online resources. The integrated

environment should serve as a means to coalesce, summarise and personalise online resources into a manageable stream of highly relevant information for both staff and students.

Members of the senior management were contemplating how best they could address the vision of the flexible learning and teaching plan. By consulting the head of the IT function, the senior management then expressed the need to introduce an internet-based solution in which all of the teaching and learning resources, services and functions could be made available in one place. The head of the IT function then consulted those senior IT staff who had expertise in the development of web-based applications for delivering services. After carefully analysing the university's needs to support the flexible learning and teaching plan, the senior IT staff and the head of IT function then recommended the introduction of a web-based portal as a solution to implement the directions provided by the plan. The senior management accepted the views expressed by the senior IT staff and advised them to prepare a project proposal. The senior IT staff then looked at the commercially available portal offerings (e.g. 'Domino', 'Latest Domino') that were available in the market at that time. The team soon realised that most the existing products were immature and very expensive. This prompted them to consider an in-house development option.

The primary motivation for the university to introduce the portal was to help positioning itself in a highly competitive education market. Portals were chosen a vehicle to create a flexible learning and teaching environment that would set the university apart from other educational institutions. The university currently prides itself as being the leader in introducing portals. This sentiment is reflected when the IT manager made the following remarks:

"We are the leader among Australian universities in relation to portals. Whenever any other university develops any portal-related applications they usually come to us and check on our applications and systems, they try to follow us as we are successful."

This view is also shared by the manager of the FLT team as he made the following comments:

"Our portal has always been the premier portal in Australia, so we are the leader in this field"

Features and Services Offered through the Staff Portal

Several dozen services are currently offered through the portal. However, the most popularly used services include: a) e-mail, b) employee self-services, c) class booking, d) research grant administration, e) handbook printing, and f) online advertisement via marketplace. E-mail service is heavily used by the university staff particularly when they are off-campus. The portal has also integration with employee self services and enables staff to view their pay-slips and leave status. There is a class booking system available on the portal and hence if any staff wants to do a library class or one of the expert research classes then they

may book it through the portal. The portal has links with research grant administration systems (which is in SAP) and it allows administration staff to look at financial snapshots. Staff are able to view all their research projects and grants. Staff can also access a system called Cupid which records information relating to printing of materials and handbooks of all courses run by the university. There is also an online marketplace where both staff and students can buy and sell things. However, only advertisement is handled and actual payment is not supported by the marketplace. Currently, the portal neither offers any functionality for online procurement nor it supports staff travel. Hence, staff cannot book and purchase tickets.

The university staff generally use a web browser (Netscape) to access the portal. They authenticate using their credentials recorded in the LDAP directory services which is the central backbone of the university's IT infrastructure. It provides a single, authoritative source for identification, authentication and profile information, such as department, role of systems access. Once authentication is successful, staff are able to view their pay-slips and leave information through the ESS (which is in SAP ERP), update a course on the courseware system, view the status of a call in the HelpDesk system or review summary information from other web resources. All these information are homogenised by the staff portal into a set of information and services that is meaningful to staff. In summary, staff can quickly log in, find what they need, change it if required, and log out again from anywhere on or off campus. A workflow model of the portal is shown in Figure 2.

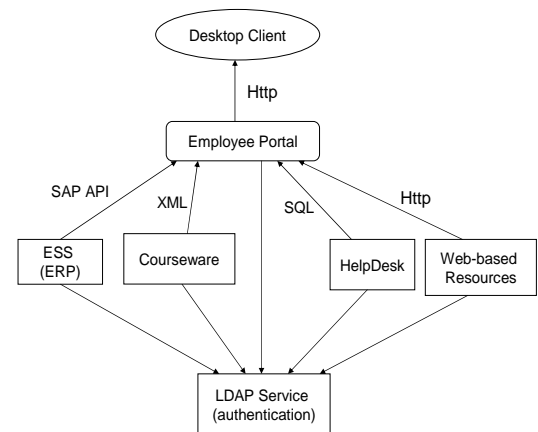


Figure 2: A workflow model of the staff portal

Portal Development Approach

The FLT group was established in the year 1999 which is responsible for developing the portal and integrating the services (discussed in the previous section) through the portal. The group consists of about fifteen people chosen from four functional areas: learning and teaching, research, administration support and information technology services.

At the initial stage, about five IT staff joined the FLT group and constructed the core of the portal. However, once the portal became operational more IT people joined the FLT group for providing on-going maintenance and training of portals.

The portal was built with an open source toolkit called 'Html mason' which is in PERL language. PERL was chosen because of its rich collection of open source library functions. The development team used about 100 library functions to offer functions like discussion groups, your directory and e-mail and many others through the portal. The development team felt the need for powerful servers to support the operations of the portal and hence several 18K domain hardware servers were acquired.

The FLT group adopted an incremental developmental process for constructing the portal. At the initial stage, a prototype was developed which was demonstrated to the senior management and many other staff chosen from several functional areas of the university. Based on their feedback, the portal was further enhanced. The first pilot trial of the portal took place in March, 2000. Based on the feedback received from the participants of the trial, several aspects (most notably interface and performance) of the portal were further improved. Eventually, the portal was officially launched in July, 2000. The FLT group is still enhancing the functionalities offered by the portal. According to the manager of the FLT team:

"We never stopped developing, we are still developing it's an incremental developmental approach. We were doing prototyping, what the people want, let's find that thing, let's build that thing and then release it."

Critical Factors Affecting Portal Adoption

A discussion with the participating executives confirmed the existence of a strong management support for the adoption of staff portal in the university. The senior management understood and appreciated the role of portal in implementing the flexible learning and teaching environment within the university, and hence offered full support for the project both in terms of providing requisite resources and academic credibility. This is reflected in the following remarks of the head of the IT function:

"The senior management was the driving force of the project. They actually provided the project with the academic credibility and the value; they could see the academic value of what we were doing and they then became closely associated with the project and their involvement was absolutely critical."

This view is also shared by the manager of the FLT team who commented:

"... Senior management support was certainly there. The portal project was not under funded, it started well."

The university had some bright IT staff members who were innovative and supportive to the needs of

implementing staff portals. These members had the right mind set, understood the meaning of portals (as very little was known about portal technologies at that time), and had the ability to train themselves about the open source technologies to be used in building staff portals. These members exploited the available set of open source tools based on the Perl programming language and created a working prototype which was demonstrated to the senior management. The prototype convinced the senior management about the ability of the in-house IT staff in implementing staff portals. Therefore, the availability of in-house IT expertise was a major factor that persuaded the senior management to introduce staff portal. According to the head of the IT function:

"Two of our most innovative staff members responded to my request to participate in staff portals. They took advantage of the available technology and knowledge to create a very prototype portal. This prototype was subsequently formed the basis to obtain an approval by the senior management."

The portal project was conceived as a direct result of the existence of a strong need for the university to provide on-line services to staff and students alike in support of the flexible learning and teaching environment. Without such an expressed need, it would have been impossible for the IT department to push the idea of establishing a staff portal for the university. According to the Head of the IT function:

"There was an established need within the university to provide on-line services to staff and students through the Internet."

The manager of the FLT team supported this view as he made the following remarks:

"They (the senior management) were thinking how they could fulfil the university's need for delivering on-line services to facilitate flexible teaching and learning objectives. They were really saying like, we want a Harvard Quality Learning and Teaching activity so that all of the resources and all of the services and functions will be in one place. This sounded like a portal to us."

The university did not invest heavily in the staff portal project and therefore did not consider the project to be an expensive undertaking. The portal was built within the existing university budget. Necessary human resources in terms of IT application developers were pulled from other projects; they were brought together to form a team. Furthermore, as the team used free open source code for developing the portal little cost was incurred for acquiring necessary software. Hence, the actual cost of development was perceived to be very low. Therefore, cost of the project was not considered to be a major factor affecting the decision of the senior management to introduce staff portals. According to the Head of the IT function:

"Yes, the portal was developed within existing budget. I

had the kind of resources/budget for various areas and I decided how to actually get a start together and activate it."

The university did not experience any pressure from the portal vendors to introduce staff portals. The head of the IT function and the IT applications manager both confirmed this view. According to the IT applications manager:

"At that time, the portal solutions offered by the vendors were not mature and there was no pressure from them on us to introduce their products".

VI. Discussion

The university neither looked at the staff portal as a means to receive direct visible economic gains nor introduced the portal in response to frustrations expressed by unsatisfied employees who had difficulties in locating university resources from off-campus. The initiative was directed at addressing the strategic vision of the university to promote itself as a distinguished educational institution by creating a flexible learning and teaching environment.

A description of the features and services offered by the staff portal (presented earlier) reveals that the portal possesses all the three broad groupings of features identified by Benbya et al. [5]. The portal allows the inclusion of documents in multiple formats and enables employees to use the search engine for locating the relevant information. The contents of the portal are customised based on the needs of each faculty. The portal however lacks tools to support on-line collaboration among employees. The staff portal has also incorporated security mechanisms and each employee is required to authenticate using a password. However, the portal does not offer any features that allow employees to customise their own interfaces or contents. Interestingly, the portal does provide employees with an access to weather information and a university operated on-line marketplace in which employees and students alike can place advertisements.

The question of whether to build a portal from scratch or purchase commercial components was critical to the university. It recognised that the commercial products offered by the IT vendors were not only immature at that time but were also found to be inadequate to meet their unique needs to implement the flexible teaching and learning environment. Consequently, the university made a concise decision to build the staff portal from scratch. The experience of the university is consistent with the views expressed by Brooks [7] who encountered difficulties in recommending a suitable employee portal for a large company. She evaluated four major portals and discovered that each one of them was targeted in a direction that really did not address the needs of the company.

The portal development team had followed an incremental approach and used prototypes to establish employee requirements and obtain approval from the senior management which according to Brooks [7], Gruhn et al. [10]

and Tojib et al. [20] is a useful strategy for developing successful e-commerce portals.

Out of the five key factors shown in the conceptual model of B2E portal adoption (Figure 1), only two factors (i.e. management support and IT expertise) have received strong support in relation to the adoption of staff portal in the university. In contrast, cost of portal and pressure from portal vendors were not found to have any influence on the decision of the university to adopt staff portals which is not surprising given that the portal development team had used free open source code for developing portal and the immaturity of the commercial available products at that time for which vendors could not press hard on the university to acquire their solutions. However, the factor that was found to have strongest influence on the university's decision to introduce staff portal is its explicit need for an appropriate technology to support the flexible teaching and learning environment. In other words, the existence of an explicit business need encouraged the university to actively seek a portal solution.

VII. Conclusion

This paper has addressed four key concerns relating to the adoption of B2E portals in the education industry. A large Australian university which has introduced staff portals in recent years provided the empirical context in which to better understand the research concerns. The initiative of the university to adopt a staff portal was found to have originated in-house and was aimed at improving its flexible teaching and learning environment and thus to set the university apart from other tertiary educational institutions. The portal was found to have included a range of features that were explained in terms of the taxonomy suggested by Benbya et al. [5]. Finally, the proposed conceptual model of B2E portal adoption has also received some support. However, the evidence from the university suggests the presence of a strong business need to be an important determinant of the decision to adopt staff portals. This particular aspect is not promoted by the portal vendors.

The findings of this study are important because, as the B2E discipline is very new and still immature, useful guidelines and success factors are not yet available compared to those of the B2B and B2C aspects of e-business. Furthermore, as the risk of B2E portal failure represents a significant financial loss for business, an important task of the e-business researchers is to contribute to the knowledge to support the business community to successfully adopt and diffuse portals. This paper contributes to this aim by investigating the factors that potentially affect the decisions of business to successfully introduce B2E portals.

The paper does not address the challenges presented by the portal or examines the success of portals from the viewpoint of employees. Thus, further studies are required to investigate these issues and to determine whether cultural factors have a significant influence on business decisions to adopt portals.

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Considering the Cultural Issues of Web Design in Implementing Web-Based E-Commerce for International Customers

Kyeong. S. Kang

The First International Conference on Electronic Business, Faculty of Information Technology

University of Technology Sydney, Broadway, NSW 2007, Australia

Tel. +61-2-9514-1912, Fax. +61-2-9514-4492, EMAIL: kyeong@it.uts.edu.au

Abstract: The web design for international e-commerce sites is becoming an increasingly important issue. This paper addresses issues about cultural differences in web design and designers' views. The summary of research work includes understanding of designers' attitudes and approaches in designing web sites for different countries. Some suggestions about important aspect of localized design are made from case studies conducted during this research.

I. Introduction

Web design for international customers is one of growing issues in web based e-commerce. This research focused on issues in the design web pages for customers in different countries, particularly in business-to-customer (BtoC) e-commerce, including an understanding of designers' approaches in different countries. This paper begins with an overview of current approaches in the global e-commerce design, and follow on to present a case study about comparisons between Singaporean and Australian web design practices. This study investigation attempts to search for an understanding of the barriers in designing e-commerce on a global level.

Web design and user interaction are increasingly important for e-commerce for information presentation to the customer, and a high-quality web design increases customers' interests and interactivity [1-3]. However web design is only on a small part of e-commerce service function provided to the customer. Most likely, cultural differences reflect in user-service provider relationships, communication channels and user expectation levels of information service functions. E-commerce service providers including web designers are stepping up their use of new technology to achieve their goals, i.e. customers get products and services that they desire and the providers provide these with efficiency. The web developers have realized the importance of providing right information for target customers so that e-commerce companies can succeed in conducting business through the Internet. There are great opportunities in different countries for niche products and services to become a part of the multinational e-commerce. It is expected that such an expansion in electronic business will support economies of several nations and create new opportunities in and around their physical locations. The

issues of suitable web design for international customers are significant factors in global business implementation. Hence the need to study web-site design practices for international appeal in electronic commerce.

II. Web Design Issues and Challenges

II. 1 Current e-commerce Service and Design

E-commerce services and design, like any other product, are not only conveyed with web providers' perspectives but also with customers' perception of choices through the communication channel of the Internet. To be precise, information on the web relies on both groups forming a common perception. In a global context, most web interfaces do not support effective usage due to use of unsuitable tool for conveying information in a global context, as most of the information is presented on the web by icons, metaphors, shapes, colors of text and background, frame/text locations on screen, etc. which may be relevant to the culture of origin but may be misinterpreted by the global audience.

Normally, web design features are directly translated into different languages at most and distributed to users internationally. In an international context, the web content features employed makes a somewhat lesser impact in the variety of contexts it is supposed to be effective in, although they may be clear to a minor proportion of the population. Thus a consideration of human factors in the design of web for an international user base is an important factor in promoting effective usage of information presentation.

Challenges of web design are how to provide appropriate information to satisfy users, and give benefits to business providers. From the designer's view, providing a good interface possibly start with an understanding of customers' interests. The following two sections describe two aspects of web design that are important for customers.

II. 2 Information on the Web

Generally, customers are interested in information, representing style and interaction with web usage, depending on the quality of information. Sometimes, the amount of graphical components supports customers' understanding. Visual information on the web is increasingly important to support information as well as interaction between customers and business providers. Visual information promotes customer understanding, acceptance and determination to purchase products from the web. In global

markets, users are sensitive to interaction with product information on the e-commerce sites.

Del Galdo and Nielson [4] demonstrated that color and web page design directions have different psychological and social associations in different cultures. More importantly, different users have different concepts of web page usage. Design of web sites normally need to consider Latin-based screen design starting from the top left-hand corner or a Chinese language style starting from top right-hand to bottom left-hand. In such difference in script writing concepts, it is very difficult to provide localized screen designs if they are not included in the original design. Resources are currently available for web designers who wish to maximize the usability of a web site including usability guidelines. Collections of human factor references, web sites intended as a gateway to human factors resources and companies offering web-focused human factors consultancy. Also Human Computer Interaction (HCI) theories, methods, techniques and tools may be applied to the study of computer-mediated communication (CMC) in general, and web sites in particular [5] [6].

III. Web Design and National Cultural Characteristics

Web design is concerned with what a web site will look like and how it will communicate with the customer [5]. The issue for Information Technology professionals and researchers, business developers is to develop sufficient theories and models to describe behavior of humans who use information systems, with the aim of designing systems more effectively. Cultural factors in information systems are likely to impact on effectiveness through web design. This study brings up web design issues in two different countries, but could be easily extended to a much broader scope. There is some literature on national culture that provides different perspectives in successful business practices or best practices, but lack depth of perspectives for e-commerce. One of the most widely used set of national cultural characteristics in business is a study by Hofstede [7]. Hofstede found that national cultures differ in five dimensions: individualism vs. collectivism, femininity vs. masculinity, long term vs. short term orientation in life, power distance, and uncertainty avoidance[7]. The dimension of individualism vs. collectivism is a suitable aspect to explore the differences between Asian and Australian web designers' attitudes. Some selected key differences between individualist and collectivist countries are described in table 1.

Individualist	Collectivist
Everyone grows up to look after him/herself and his/her immediate family only	People are born into extended families or other in groups which continue to protect them in exchange for loyalty

Identity is based in the individual	Identity is based in the social network to which one belongs
low-context communication	high-context communication
employee-employer relationship is a contract supposed to be based on mutual advantage	employee-employer relationship is received in moral term, like a family link
management is management of individuals	management is management of groups

Table1. Differences between individualist and collectivist (source from Hofstede's study [7])

Australia belongs to a high individualistic group, whereas Singapore belongs to a collectivistic group. From this fact, the study of web designers' approach and their attitudes can be a basis for comparison that might help e-commerce practitioners in developing successful applications. Particularly it will help in creating a basis for designers' preferences and attitudes that cater to the requirements for web design in different cultures.

In general, a good web interface provides user satisfaction and conveys trust, such that a user can easily find general bearings of the information presentation scheme and retrieve the information they need. Design of web sites for effective performance is a complex and highly creative process. It combines intuition, experience, and careful consideration of numerous technical issues and investigations [8]. Moreover without proper consideration of cultural factors in design, the impact of culture is undermined and certainly does not position as an important issue. Culture influences certain methods of performing tasks, even common tasks in certain ways. Practices result from life long training of human and set rules and circumstances. Hence, localized e-commerce site deal with how differences between people from different cultures impact their behavior in specific circumstances. History and values can also impact on user's perception. E-commerce advocates have substantial claims made for the web's effectiveness as a tool in the sales process to customers. However, little real research has addressed these factors that will make customers buy, when in electronic shopping malls. Findings from cultural factors research for e-commerce could be beneficial for web developers catering for a domestic customer base, as well as for an international market with the specific understanding of their culture and the human behavior it promotes. Particularly, understanding of designers' aspects from different countries through this study may add more value to web design in e-commerce sites for the benefit of providers as well as customers.

IV. THE CASE STUDY

IV. 1 Study objective and Approach

The objective of this research was to find out web designers'

preferences when they design web sites, and determine their approach in different countries. Generally, web designers apply their knowledge and ideas while designing web sites, negotiating the final content with businesses so that both have a common understanding of the information being offered to the community. In this paper we investigated designers based in two different countries, Australia and Singapore to study their approach to web design for e-commerce. There are many ways that culture can be reflected in the web design and this influences their way of presenting information on the web. This research seeks differences in designers' aspects through cases, such that the outcome may provide some benefits to web providers and global e-commerce companies.

The research method that was used in this study was exploratory case study. The case study approach was utilized as outlined by Yin (1994). The qualitative research method was used to answer questions about the people's behavior towards effective web design. Yin (1994) defines case studies as "an empirical enquiry that investigates a contemporary phenomenon within its real life context, especially when the boundaries between a phenomenon and context are not clearly evident". Case studies are especially effective for studying the subtle nuances of attitudes and behaviors, and for examining the web design processes and implementation. The case study was the preferred method used in this research, since what this research sought to obtain was the depth of understanding of the designer's attitude and behavior within a particular setting or context.

The process involved interviews of participants and also studying the web sites developed by these participants. This meant that more than one research method had to be used for data collection. However this approach was beneficial to confirm the generalizations and to test the impact of cultural differences on web design. This research attempted to formulate more precise objectives for further research.

The research approach used a qualitative approach, which involved the use of interviews, documents and participant observation to understand the social and cultural phenomena. For this research, although cultural generalizations needed to be confirmed, it was realised that cultural differences cannot be revealed directly. The research method that was used in this study was exploratory case study [9]. The process involved interviewing participants and also studying the web sites developed by the participants. This meant that more than one research method had to be used for data collection. However this approach was beneficial to confirm the generalizations and to test the impact of cultural differences on interface design. This study attempted to formulate more precise ideas for further research.

There was a study based on the Hofstede's dimensions (1997) of collectivism and individualism on web design by del Galdo and Nielson (1996), comparing Japan and the United States. They mentioned that collectivist-type users would like to have common behaviour as a group at an organizational level, and under individualist users want to

have control over their surrounding environment. Singapore and Australia are similar to the example presented by del Galdo and Nielson's comparison of Japan and the United States, Singapore being the collectivist culture and Australia being the individualist culture. Hence these characteristics can be reflected in typical attitudes used in e-commerce. Singapore is a collectivist society as identified by Hofstede (1997), while Australia has an individualistic culture. Based on Hofstede's findings, we decided to select companies from two countries; Singapore as for a collectivist society, and Australia as for an individualistic society. Ten cases were reviewed with over ten web designers/developers from five companies each in Australia and Singapore. These case studies were conducted through a combination of face-to-face interview, email and on-line interview. The data were used from selected participants to draw conclusions about the impact of cultural differences on the interface design. The case study used interviewing as a primary method for gathering data from each of the cases. An informal, semi structured, interview style was used. This style of interview allowed participants to express their own views freely and allow participants to feel comfortable during the interviews. The interviewer conducted the interviews using a set of open-ended questions, and built up the case.

The focus on data analysis was on findings patterns and regularities within the data. The analysis included data reduction, display and verification. The data were used from selected participants to draw conclusions about the impact of cultural differences on the interface design. In this research, web design components were divided into six attributes of display colors, image representations, symbols, animations, pictures and functionality (see table 2). Then web designers' preferences and attitudes were observed in creating new web page designs.

Web design components
Use of display colors
Image representation
Use of symbols
Use of animations
Use of pictures
Functionality of the web site

Table 2: Web design components divided into attributes

V Findings

In general, Australian designers preferred to have more functional websites such as ordering and search options. In contrast Singaporean designers preferred to display information on images rather than focus on text information. Singapore designers maintain and change information on web site more frequently than Australian. Australian customers preferred more direct and open communications, content oriented web sites and did not importance on picture

information. For instance, Australian web developers and companies had no particular preference of colours, animations, pictures and symbols. However company prestige was considered to be more important than image, and mainly used text based information. Australian designers feel that they have right to contribute own opinions to build up a web site. Also customer reaction was considered as the major influence on design, so that, they provided information with images, animations and company logos as per companies' requirements. Australian companies did not perceive signs and symbols to convey meaning. Australians believe in doing things to build trust.

Those interviewed Australian web designers mentioned that web sites could be created not only depending on clients' requirements but also generating their own ideas. Web designers emphasized that web design was a collaborative processes between clients and designers. Company managers were a part of the web design team. A new application was used only when it integrated into the design and they felt comfortable with using the concept. Some findings are summarized in Table 3.

Table 3: Web designers' preferences in two countries

Singaporean Designers	Australian Designers
-Use particular color scheme (depends on companies preference)	-No color preference from companies
-Company logo is important	-Company prestige is more important than image
-Not prefer any particular symbol	-Not prefer any particular symbol
-Prefer to put many animations	-Consider to use animations but not many
-Large and many numbers of pictures	-Not to put pictures, and prefer to put text-based information
-Customers are not main consideration	-Customer reactions are major influence on design

In case of web site maintenance and changes designers were able to manage or easily update public information if designers thought it was appropriate, another reflection of individualism. Australian designers applied more individual opinions, and were less sensitive to the use of graphic images on web sites compared to Singaporean designers. Besides the above case study, we examined ten selected IT global sites based in USA. Apparently there were no different web design features for different countries in international Electronic Business. Most of international e-commerce sites from an additional investigation concluded that sites use similar image design for international users as for home-based users. This indicates that international market providers (mainly USA based) use the same pattern

of colors, symbols, and images on the web in different countries.

VI Discussion

The study result demonstrates that, designers from different countries have different approaches, and provide different web features. Also visual-information is an important source of communication between business providers and customers on the web. Designers and developers need to be aware of their customers in different countries. Currently there are many different approaches to dealing with cultural issues, as applied to the problem of how to support customer goals using the e-commerce site; two dominant approaches are discussed below.

Cultural aspects

Cultural aspects' impact on globalization of web design in web-based E-Commerce is essential. Web developers need to consider that the users are located in different geographical locations and belong to different culture backgrounds. The significance of web design is usually directed to the management while leaving the user out of consideration, unless specific problems arise and are addressed. Turk and Trees [10] mentioned that global Information Systems on the web should be developed in such way as to localize information and design for different culture background users. Web applications could be adopted for local users rather than be internationalized to produce a cultural relevant user interface. Information presentation on the web needs to be considered in localized web design context with globalized information.

VI.1 Working relationships

The result indicates that designers and company managers are also from different culture backgrounds in terms of belonging to sub-cultures, and may have different goals to provide information presentation on the web. Their relationship is critical to provide the right information presentation to customers at the right time. Web design in approach should be a collaborative process, where establishment of a working relationship between companies and web designers is a major starting point in the design process. This promotes a common perspective to information presentation for the customers and further if target customer's cultural dimension is taken into consideration then it is likely to promote business objectives of trust and effective information delivery.

VI.2 Conclusion

The case studies as described in the previous sections, although the cultural background of customers and designers that is very important for web design, current design practice takes minor account of cultural issues. Many global business web sites have been designed and developed with absence of understanding of customers and their cultural differences on the global scale. Customers' expectations are not taken into

consideration in designing the functionality of web sites in global business companies. Apparently Australian web designers are more customer-oriented in web design, in comparison to general global business web designers though they appear to be less sensitive to the use of graphics on the web. The web sites of leading Information Technology companies studied in this research did not have their interface to account for different user cultures. This research found that designers' approach from the two different countries were dissimilar for web design in electronic business applications. This study also concluded that there is a need for localized web interface design to transmit the meaning of a business concept on web sites in various locations.

In addition, there is increasing attention to investigate ways to develop e-commerce sites for different countries. Future Electronic Business technologies will definitely introduce more attractive and convenient tools for the customers from different countries. Moreover, web image components are better suited to be used in certain ways to improve web based e-commerce. Not surprisingly web

images are being used a lot to attract customers and increase company's presence in the global e-commerce.

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Successful E-Commerce: The Importance of Brand Management

Darlington Onojaefe *, Andy Bytheway **, Geoff Erwin***

* Faculty of Business Informatics

Cape Peninsula University of Technology

Tel: +27 21 469 1041, Fax: +27 21 469 1002

onojaefe@telkomsa.net

** Faculty of Business Informatics

Cape Peninsula University of Technology

Tel: +27 21 469 1026, Fax: +27 21 469 1002

bythewaya@cput.ac.za

*** Faculty of Business Informatics

Cape Peninsula University of Technology

Tel: +27 21 469 1018, Fax: +27 21 469 1002

E-mail: erwing@cput.ac.za

Abstract: This paper identifies and examines evidence of e-commerce failure in small and large businesses, focusing specifically on their Internet branding strategies, the impact of management actions and how those actions contribute to e-commerce success. This paper argues that as we move to a more interactive mode of working with customers and competitors using Internet technology, the role of marketing is critical; within marketing, brand management is seen as a particularly important activity.

The work reported here assembles evidence that brand management is indeed important, and that there is a lack of theories to guide brand management activities in an Internet context. Internet-related partnering opportunities with large firms remain a concern for smaller firms. It also reveals that much Internet research has taken a technical viewpoint although some experts have begun to make connections between Internet success and brand management.

I. Introduction

This paper presents an analysis of a retail company in South Africa. Though it seems too early to generalise about e-commerce failure or success in business, and in particular businesses in the developing African countries, it is hoped that the e-commerce experience of the company reported here could lay a solid foundation for others that set out to explore the many opportunity of modern technology. Businesses have made huge investments in Internet technology, often with little or no benefits. Yet, the Internet remains an important and viable communication channel for all kinds of businesses, particularly small businesses with scarce (financial, managerial and technological) resources. This research aims to provide evidence of e-commerce success factors and a categorisation scheme for small businesses.

According to [1] the Internet is important because it allows small businesses to gain access to information about

larger businesses, making it a cost-effective source of market intelligence. Yet for many, the benefit is perceived to be only basic communication such as is provided by email.

Nevertheless, the Internet has transformed – and continues to transform – the way many people live, work and play, according to Bray [2]. This transformation has important consequences for the management of national economies and business activities. The unrealised commercial potential of Internet technology is significant and continues to attract substantial investment. One should endeavour to make sure that these investments are effective, especially where they affect small businesses. The question therefore arises: what should a business do to ensure success, and what in particular does a *small* business have to do to avoid wasting precious money and resources?

One of the key consequences of the Internet for today's business is the emergence of e-commerce. The unique interactive feature of Internet technologies provides businesses with numerous potential benefits [3]. These benefits help businesses to meet their promotional needs and manage their customers' changing expectations – all critical components of what is generally termed “brand management”. For small businesses, this is not a quick fix. How should small businesses manage business relationships using Internet branding strategies? The Internet offers rich synchronous and asynchronous communications potential that is impossible using traditional technology such as telephone and facsimile. The multimedia and data transferability of the Internet (according to [4]) makes it easy to interact with different communities such as staff, business partners and customers. It is noted further that management enthusiasm and support for “remote relationship management” through the Internet is consistent and continuous.

The need for this study

This paper describes a study of the ways in which businesses can successfully develop and manage Internet brand equity within their overall marketing communications strategy. The intention is specifically to help SMMEs understand the

importance of the Internet, because they are especially vulnerable and must understand not just the importance and potential of the Internet, but also the good management practices that will deliver success.

Sources of difficulty

Brand management has been identified as an area of special significance, but it is not the only potential problem area. There are other areas in business such as project management, human resource management and financial management, any one of which might impede the success of an Internet investment. Any one of these, badly executed, will stifle e-commerce initiatives; small businesses will be particularly susceptible as there may be just one person trying to implement all elements of an initiative at the same time. The problems of a small business may well emanate from an inability to recognise and manage new business processes, arising from the use of the Internet, that then fail to link the e-commerce investment with the strategic benefits of well managed brand equity.

Though other areas of management activities might be significant, this paper argues that the question of branding is sufficiently important to provide the initial focus; other problem areas can be noted and investigated as they prove to be significant.

First, there is a brief review of relevant literature. Then, a conceptual model is described that relates some of the critical issues that must be managed and that provides a basis for a research design. Finally, a case study is presented and discussed in the light of that conceptual model.

II. Background

The existence of the Internet adds a new *communication channel* between a business and its customers, suppliers and partners. This has the potential to support brand management efforts, but equally it has the potential to confuse it. It is argued by experts that with multiple brands and multiple communication channels, branding activities can fall short of ensuring business success unless continuously improved brand equity is used as the strategic driver of the marketing communications effort [5].

A brand (according to [6]) is "...a distinguishing name and/or symbol (such as a logo, trademark, or package design) intended to identify the goods or services of either one seller or a group of sellers, and to differentiate those goods or services from those of competitors." The author notes further that brand equity is the total sum of: brand assets and liabilities, the brand name, and symbols that add to or subtract from customers' perceived value of the brand.

Others take a different view, seeing brand equity as the outcome of a process that is aimed at creating customer-based brand equity. The value of a brand is based on customers' assessments of the brand. This assessment is achieved through links to secondary associations that the customer can easily identify with.

The complexities of brand management become apparent

as one reflects on these definitions, and the challenges to a small business will clearly be severe. Establishing good brand management practice that will minimise the risks and maximise the benefits of Internet investments will clearly be helpful.

E-commerce and small business

It is pertinent to recognise that business practice in a large firm is different from that in a small firm [7], and that the e-commerce needs of a small firm are understood through an exploration of the unique aspects of small business and their practices. For example, large businesses are often presumed to have the resources to achieve difficult things, and yet it is possible for a small business to be much more "professional" than a large business – a large business is frequently hampered by cumbersome processes of debate and decision, a small business can move quickly and more easily assess the impact on customers and other partners.

These realisations, and the fact that little reported work seems to be available concerning these things, led directly to the initiation of this research.

The importance of business partners

E-commerce is not an activity that concerns only one business. In all cases, by definition, e-commerce involves more than one party: a business and its customers, or a business and its partners; possibly a business and a government agency or regulatory authority. It follows that research can not be confined to one organisation, the views of the other party must also be understood. It is therefore important that the collective interest of small businesses *and* their e-commerce partners is established, because in e-commerce more than one party is always involved. A business does not do business with itself (or, if it does it is comprised of *different business units* – unlikely in the case of small businesses). The views of all stakeholders involved in SMME-related business processes need to be elicited, as all involved parties must benefit from an e-commerce enterprise for it to be entirely successful [8] (except perhaps the involved party that comprises "the competition").

Branding and the Internet

As has been noted, the impact of the Internet can cause the introduction of new kinds of business activity. Where a business is unwilling to undertake significant change, then the benefits of e-commerce investments might be severely limited. The adaptation of business processes can now be so radical that the overall effect (on business *communication* processes in particular) now extends far beyond what we have become used to in traditional business practice [9]. The Internet has become the agent of change in organisations, seen through new access to new information and new societal processes that would be unthinkable without the Internet, creating new forms of business and consumer interaction [10]. Achieving the benefits of this new interaction depends on key factors such as communications and general management [11]. Overcoming communications

barriers (possibly involving differences in cultural background and different languages and vocabularies) will allow managers to deal successfully with many Internet-related problems.

The Internet has opened up new business opportunities, in particular access to new markets arising from the extended "reach" that comes with the Internet. This means that approaching new markets, possibly in remote places, requires that managing *brand* will be important and that there will be a necessary increase in *branding activities*. Marketing is the means to address the needs of new markets, and the brand is the thing that must be established for the market to be persuaded to respond. That is why the Internet and Internet branding are important.

There are other concerns about the contribution of e-commerce to business success [12] that will require changes in management strategy, but there is not sufficient available information to establish the facts about e-commerce success, and again the need for this research is emphasised.

The linking of computers to different networks through the Internet allows data to be transferred between two otherwise incompatible machines; a level of data communication becomes possible that would have been unthinkable just a few years ago [13]. The transferability of data through the Internet creates an opportunity for development and management of cost effective business relations, through the interpretation and management of data as the *information* that facilitates the transacting of business between partners.

A review of communications management in the Internet-dominated environment is necessary, to understand the potentially negative impact it may have on Internet investment benefits for small businesses.

III. The Strategic Importance of the Internet

The emergence of the Internet has created a situation of strategic uncertainty. As a consequence of this, the strategic importance of the Internet to business has come to the fore. For small businesses entering this environment, a management strategy that defines and manages the firm as a brand could be helpful.

Angehrn [14] argues that Internet activities can be categorised into three stages: (1) Internet presence, (2) interaction and, (3) full e-commerce. At what stage of the Internet activities do we need to involve branding? Angehrn's framework helps us to understand this.

Stage one

At stage one, a business typically mounts a web page or two in order to disseminate product and service information to customers and potential customers alike, and to provide contact information in the form of telephone numbers and email addresses. At this stage the medium is new, as is the management intent, and there are basic lessons to be learned. Therefore, a lack of insight into the critical strategic issues of brand management will already reveal itself. To deliver

true and consistent product and service value to customers the whole organisation and all its activities should be managed as a brand [15]. The change in communication medium (using the Internet) introduces changes in the relationship between perceived organisational values and perceived customer values, that must all be satisfied to establish internal and external satisfaction. Even a few web pages that establish a presence (no transactional capability, no e-commerce) can convey the wrong messages and undermine efforts to establish a consistent and coherent brand identity.

Stage two

Stage two provides transactional interactivity through a web browser, for example using forms and scripted program code at the server (ASP, PHP or similar). Waterman [16] argues that stage two in the Angehrn model has the potential for two-way communication, including transactional and messaging capability within the web- and browser-based system. Although this two way exchange is possible using other traditional means, such as telephone and fax, clearly we are interested in the advantages that might arise from use of the Internet and this research is therefore focused on the use of the Internet and its advantages.

At this second stage, a lack of trust on the part of the customer and lack of strategic overhaul of management philosophy threatens to inhibit the customer relationship management effort. Businesses depend on personal networks and social interaction as a way of building trust and managing customer relationship. The implication is that the trust that is so important to relationship management and so traditionally dependent on face-to-face interaction, cannot be developed in a context like the Internet [17,18,19]. More research is required in the area of remote relationship management and the building of online trust, separate from or in parallel with face-to-face relationship management.

Stage three

This third stage of Internet maturation includes more dynamic features such as bulletin boards and chat rooms, as well as the use of audio and video facilities to improve the richness of the Internet-based interaction. Again, an evolved management philosophy is needed to develop and deploy creative brand management tools for effective and efficient customer relationship management at this level.

Summary of strategic importance

Brand management typically (but not always) starts at the first stage and progresses with increasing intensity to stage three, where more and more interaction with external stakeholders is committed to the Internet, making it more and more important strategically. Internet brand equity increases with this intensity and the risk of conflict with other branding that is delivered in conventional ways increases; full implementation of e-commerce implies full implementation of branding and brand management on all channels, not just on the Internet alone.

Hence, branding activities must increase once web-sites have become full e-commerce sites. Experts argue that Internet branding is beyond the general focus of day-by-day business attention [20, 21, 22]; it is of course necessary to view *all* management actions holistically, and to understand their overall ability to contribute to brand equity as well as to the other domains of business activity. Therein lies the challenge to all businesses adopting the Internet, especially resource-starved small businesses.

IV. Brand Management

One important attribute of brand management is the ability to react to changes in society and market dynamics, so that good communication of brand essence is established and sustained. Key factors militating against easy brand management include rapid changes in the business environment (market complexities, competitive pressures, global forces) and the challenges of information management (with the advent of advanced information technologies that allow information to be abused as easily as it is mis-managed). Establishing *online* brand recognition that complements the *offline* brand will reduce the risk of failure.

Small businesses are likely to fail in the Internet environment if they do not realise that some Internet solutions are designed for large businesses, and do not particularly fit the needs of small businesses. Information management that is crucial for building online brand and managing customers' relationship on the Internet could not support small business e-commerce initiative. Ward and Lee argue that unlimited information access on the Internet supports the need for building online brand to save customers' time and search cost [23]. Though too much information on the Internet can be problematic to customers, small businesses need more information (rather than too little) in order to develop and deploy successful branding strategies.

A small business that is already uniquely established knows its product and service offering, as well as its target market. With the information provided by the Internet, managing the expansion of these target markets nationally and internationally will be more easy and cost effective than without the Internet. In a highly competitive virtual environment small businesses armed with sufficient competitors' and customers' information could create brand association to locate and respond effectively to each target market. According to Varian [24] the information management ability of small businesses will remain relevant despite the changes that will be introduced by the Internet. Varian argues that unique brand strategy and up-to-date customer information accentuates the brand management effort of small businesses. For significant profit potential and customer conversion, the brand management competency of

small businesses should improve customers' product-association level, (customer benefit) as a differentiation strategy.

Internet technology has changed the traditional (brick and mortar) cycle of product development, distribution and retailing to what is sometimes referred to as "brick and click"; the difference with information flows enabled by the Internet is that customers' tastes and needs can be observed, tested and analysed throughout the product development cycle [25] – what the market needs can be far more easily seen, at all points in the chain of supply. This visibility provides opportunities for changes in management philosophy, seeking simplicity and pragmatism in business operations where there was once chaos and confusion. For example, Dell's made-to-order computers, Dunhill's customised software and Google are a few examples that illustrate how technology has been used profitably to satisfy customers' needs [26].

If investments in Internet technology have not been successful, we have to realise that it might not be a consequence of poor technology. Rather, it might be the result of inadequate business competencies, such as a failure to develop a viable business strategy properly based on brand management and linked to Internet implementation issues. A holistic approach is needed to improve business-to-business, business-to-consumer and business-to-employee relations, all of which stand to benefit from good brand management.

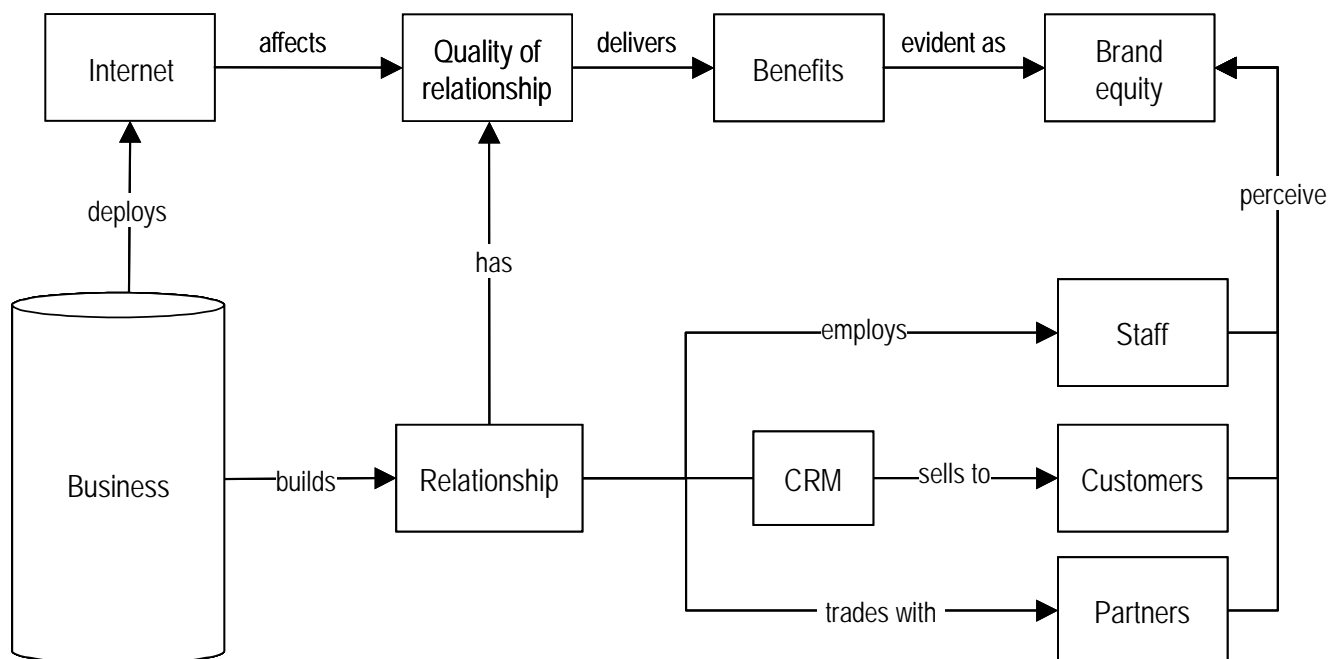
V. Methodology

This review of the literature has found that it is necessary to examine the relationship between Internet investments and business success, as seen through management competencies such as (indeed centred on) brand management. Whilst there are many success factors described in the literature, brand management issues recur and the adoption of brand management perspective shows some promise in establishing the elusive holistic view that experts consider necessary.

This study sets out to assess the importance of brand management in achieving Internet success. At this stage, the experiences of a single large business are used to establish the viability of the conceptual model. Further work will apply deploy it in the analysis of other kinds of business, including small ones and business partnerships, and thereby refine it so as to develop an improved understanding of how adoption of the Internet can be made to work successfully.

According to Poon and Swatman [27] such an understanding will help us to understand current issues and the future activities needed to provide improved quality of business relations; branding strategies are a means to achieve this objective.

Figure 1: Conceptual model of the research domain



Use of case studies

Benbasat, Goldstein and Mead [28] state that in the field of information systems, the case study method is particularly useful to investigate these types of problem: where research and theory are at their early stages and where practice-based examples reveal important factors, and where the context of actors' experiences and actions are critical to understand.

In the fullness of time multiple case studies will be used, so as to yield a variety of results that would not emanate from a single case study, but only a single case study is reported here. The merits of single and multiple case studies suggest that multiple case studies should be regarded in the same way as multiple experiments – the rationale being that multiple case studies are desirable when the research objective is to build and test models and theories [29, 30]. One case study cannot be used to draw a generalised conclusion: Yin [32] states that findings cannot be applied in general term using one case study, and this project is intended to deliver results that can be generalised. However, the intention at this stage is simply to assess the model through deployment in a single case.

Research into Internet branding strategies is a relatively new idea and therefore challenging, especially in the specific area of small businesses and their customer relationship management. The case study is therefore considered to be the most suitable in this particular research, because, as argued by Myers [31] it is the most common qualitative research method used in describing information systems and

their relationship with real life. Myers argues that the case study ensures continuous interplay between collection and analysis of data, and is especially useful in the field of information systems where attention has moved from technical matters to organisational issues of success. That is precisely the situation here, where there is clearly much published research into the technical aspects of the Internet, but relatively little into the soft issues.

The case study method allows the simultaneous collection and analysis of empirical data, hence another reason for adopting this method is to ensure that the findings are relevant to a wider segments of small businesses through continuous improvement in the understanding.

Conceptual model

The model above (Figure 1) depicts the research domain, drawn from the literature as it is seen at this stage. It can be described as follows:

Practically, a business undertakes to build different kinds of relationship with their stakeholders – principally *customers*, *staff* and business *partners*.

Dealing with the relationship with customers is often referred to as “customer relationship management” or CRM. No doubt the relationship with partners and employees is the subject of similar thinking on the part of the specialists concerned.

Brand equity is seen as the sum of all the perceptions of these key stakeholders (and other related things).

This deals with the lower part of the conceptual model,

which can be argued to represent “conventional thinking”, that is, before the introduction of the Internet. This is shown in the upper part of the model.

The Internet is an investment in technology and systems that should enhance the quality of the relationship with stakeholders.

Quality in the relationship leads to real benefits, judged not by the “IT department” but by the stakeholders themselves.

The manifestation of these benefits is seen as increased or enhanced brand equity.

In this way, brand equity is not just a feature of good marketing, it is seen as an indicator of success arising from the introduction of new technology. The detailed examination of brand management and its contribution to Internet success in small businesses will be designed around this model.

The case analysis of Woolworths, a South African retail company, is presented below.

VI. Case Study: Woolworths

History

Woolworths was established in 1931 and is generally perceived to have built a reputation for innovation, quality, value and professional integrity over 74 years of operation. The company sells a wide range of food products, clothing and homeware in two hundred stores nationally. One of the most important assets of the company is said to be its employees: they “*protect the brand in everything they do by upholding the highest standards of business practice and corporate governance in all areas of the business*”. The company strives to ensure that it acts responsibly to all stakeholders including customers, suppliers, employees and shareholders.

The introduction of e-commerce

In 1998, Woolworths (Pty) Limited set up a project team to investigate the opportunities of online retail service offering. Collin Hall, former CEO of Wooltru played a vital role in this initiative, that drew for implementation on the expertise of an IT company known as *definitive-logic*. In 2000, an operating company known as *Inthebag* emerged, following the sale of Woolthru assets to Woolworths. At that time, the investment in the e-commerce project had already consumed a reported R30,000,000; newspaper reports some three years later reported steady, but not remarkable, growth, and therefore there is an air of caution in the air. Perhaps the potential benefits of e-commerce have been very much overstated?

The situation today

Inthebag (Pty) Limited is now responsible for providing commercial e-commerce services to Woolworths and manages the online contract with customers for selected Woolworths merchandise.

The e-commerce operation of Woolworths in South Africa today is under the leadership of Keith Scott (general manager, e-commerce operations) at the head office in Cape Town, South Africa.

He explains that all core activities of the company are divided into three categories: operational management; process management and brand management. The brand management function runs through other management activities including the online services that support operations. All these function are separated organisationally, but tightly aligned to one another for consistency and coherence.

There is a history to brand management at Woolworths. With 74 years in business, the Woolworths brand has developed and established strong relationships with many customers. Extending this relationship to the online (remote) environment requires a great deal of trust between the customer and the brand, Scott considers. He understands that they rely on this trust to drive the e-commerce operation forwards and break through the barriers that they still face in the online environment. He affirms that the truly innovative challenge is how to continuously extend and replicate this trust that derives from their history of retailing, into a versatile online environment. This is clearly a challenge that they are still willing to pursue.

Benefits of e-commerce

According to Scott, benefits are slow in coming. Inthebag is still seen as a new business channel that the company will continue to develop, even though there is no immediate benefit. The e-commerce operation is seen as providing a strategic opportunity to extend additional service offerings that will help to retain existing customers. Customer retention is a huge strategic challenge that Woolworths wants to address, and e-commerce is one way to achieve this, through continuous and consistent delivery of service value that is innovative, professional and convenient for customers.

However, the present scenario of high cost and low volume is worrisome, but Scott considers that the company cannot renege on its commitment to ensuring customer retention with good Internet-enabled customer relationship management for that segment of the market that does actually value Internet-based services. He believes that effective customer relationship management will ultimately lead to improved brand equity.

Achievement of benefits

To achieve this objective of successful customer relationship management, the business continuously mines customer personal information using e-commerce technology. They use the resulting information to analyse customer needs and package products and services that satisfy those needs. The result has been an increase in market share and profit for the Woolworths brand, although it is not clear what portion of the customer relationship management success is attributable specifically to Internet based e-commerce operations.

Strategic significance of the Internet and brand management at Woolworths

Scott is clearly committed to further use of the Internet and he recognises the pros and cons of extending brand management to enhance customer relationships.

Others in the management team include Anthony Dean (brand manager), Sean Smith (customer relationship management), and Phila Ndarana (e-commerce manager). When asked, they all stressed that online customer relationship management is a crucial managerial function and they believe that only a professional, innovative and progressive company can work to overcome the trust barriers that might prevent e-commerce success.

This common commitment suggests a high level of strategic awareness of both the opportunities and the risks of e-commerce. Trust is clearly in their collective consciousness; they consider that a growing increase in online trust, arising from their strategies, has created an atmosphere of confidence in the whole e-commerce operation. Out of the 90,000 registered online customers, 17,000 are active online shoppers (very similar figures to those reported by other comparable retailers such as Pick 'n Pay). This represents 19% of the prospective online customers, and with various ongoing innovation, they intend that more customers will be converted and committed to active online shopping and – just as important – retained as online shoppers in the coming years.

Assessment of the conceptual model

One business is revealed to be committed to the use of the Internet, and there is no hesitation in their belief that this can contribute to the improvement of the quality of relationships. However, the respondents in this initial study refer only to relationships with the customer, and apart from the fact that they themselves have a high level of unanimity in their commitment to e-commerce and brand management strategies, there seems to be little consciousness of the importance of staff and business partner relationships (or the unimportance of them). This requires further investigation and might be revealed when more managers from other internal functions are interviewed.

With this exception, that a more complex range of relationships might be affected by the introduction of the Internet and e-commerce, this case study fully justifies the focus on marketing and brand management as an important, even critical, feature of successful e-commerce implementation. Having said that, actual e-commerce success and hard evidence of brand equity is not necessarily apparent, so in a sense it is actually shown that even five years after initiation of e-commerce at Woolworths, the “jury is still out” and there is much more work to be done before we can draw confident conclusions.

VII. Conclusion

The fundamental principles of branding and brand

management will probably remain unchanged, despite the radical changes associated with doing business on the Internet. This paper has found that business opportunities created through the Internet are seen as potentially beneficial, provided that adequate attention is given to the implementation of branding strategies that recognise the dynamics and characteristics of the Internet, and even though it is clearly still early days, and the patterns of management activity and action that will ensure success are by no means clear.

Large businesses like Woolworths are sometimes dependent on small businesses. Where this study has focused on customer-side e-commerce (the side of the consumer, in this case), it is possible that e-commerce on the supply side will be equally if not more interesting. As businesses like Woolworths struggle to achieve the customer side benefits, perhaps they will be drawn to review the merits of e-commerce on the supply side, where (it is important to note) they have far more influence over whether their partners will join in; customers can choose to shop elsewhere and frequently do so – suppliers are far more interested in doing what the buyer would like them to do.

Customer-side or supplier-side, the evidence indicates that the benefits of e-commerce investments will have a lot to do with branding strategies and brand management.

Because of the evident difficulties revealed by this case study, the availability of fully developed and tested models such as that presented here will enhance the prospects for success through good branding and good customer relationship management, especially in those challenging situations related to the introduction of the Internet and e-commerce.

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The Effect of Online Feedback Mechanisms in Electronic Markets: A Field Study Perspective

Her-Sen Doong Ching-Kuang Hsieh
National Chiayi University

hsdoong@mail.ncyu.edu.tw s0931308@mail.ncyu.edu.tw

Abstract: Online feedback mechanism, best known right now for building trust and reputation in electronic markets, are regarded as a major player in the success of many online trading communities. It can reduce sellers' anonymities, mitigate the buyers' risks, and affect the price premiums. In this paper, we investigate the relationship between feedback mechanisms and price premiums by the analysis of field data. An intelligent agent is build to collect actual data from Yahoo Auction. The research results will also allow us to better understand whether positive/negative rating has different effects. It may also clarify mediating effects of product characteristics on the relationship between reputation systems and price premiums.

Keywords: Feedback Mechanisms, Reputation, Online Auction, Trust.

I. Introduction

In the past several years market exchanges have been done in ways that were not possible before. This is due to the development of technology online business activities rapid increase. People can now perform commercial activities without meeting their trading partners (Xu & Yadav, 2003). Online auctions, as a new form of E-Commerce, provide new opportunities for people to exchange products efficiently and conveniently. According to the report of Yahoo Auction in Taiwan, transaction amount reached 10 billion NT dollars in 2003. Many sellers have even started to consider online action transactions as full-time jobs; thus raising the importance of understanding factors that impact online auctions.

Nevertheless, online trading is regarded as risky because trading parties may never have met. Traders have little knowledge about the identities of their trading partners and the real conditions and qualities of products (Xu & Yadav, 2003). According to the report announced by Internet Fraud Watch in February 2005, online auction is counted for 51% to rank first in consumers' complaints in 2004, which is about 765 dollars that each consumer loses. Here trust becomes an important issue in the online transaction environment, especially in the online auction market. It is essential for both buyers and sellers to identify the others' trustworthiness.

Online feedback mechanism, best known today as a mechanism for building trust and reputation in electronic

markets, are regarded as a crucial role in the success of many online trading communities. They are large scale online word-of-mouth communities in which individuals share opinions on a wide range of topics, including products, services, and companies (Dellarocas, 2003). The feedback mechanisms can reduce the sellers' anonymity and mitigate the buyers' risks (Gefen et al., 2003). While one would expect the feedback mechanisms to benefit only the buyers, the sellers benefit as well. Strader and Ramaswami (2002) investigated the level of importance of factors affecting online buyers' decision making process. Their research result shows that trust, using feedback profiles as a proxy, significantly affects price premiums, which decreases as the transaction value increases. Ba and Pavlou (2002) also indicate that higher positive rating increases the trust of buyers and makes price premiums.

That being the case, however; it is important to note that these studies primarily depend on surveys of individuals' perceptions or observations of subjects in a controlled experimental setting. They do not account the effects of online feedback mechanisms from an actual behavior perspective. In this paper, we investigate the relationship between feedback mechanisms and price premiums by the analysis of field data. An actual behavior data illustrates the relationship between feedback mechanisms and price premiums. The research results will also allow us to have a better understanding of whether or not positive/negative rating has different effect. It may also clarify mediating effect of product characteristics on the relationship between reputation systems and price premiums.

II. Conceptual Model

Figure 1 presents the research framework for the study. Feedback profiles with both positive and negative rating affect price premiums. It is moderated by product characteristics.

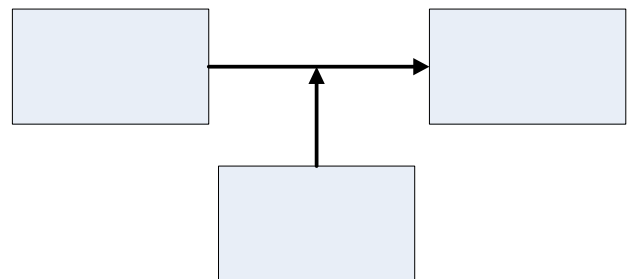


Figure 1. Research Framework

Trust

Following Ba and Pavlou (2002), trust is defined as the subjective assessment of one party that another party will perform a particular transaction according to his or her confident expectations, in an environment characterized by uncertainty. There are three sources of trust that can be distinguished in E-Commerce (Gefen et al., 2003): calculative-based trust, institutional trust, and familiarity. Familiarity through repeated interaction are not possible in most online transactions (Xu & Yadav, 2003); because institutional structures in the online world are not yet well-developed (Fung & Lee, 1999). The most prevalent source of trust in non-repeated transaction environment is probably calculative-based trust, which means that it is not worthwhile for the opposite party to engage in opportunistic behaviors (Doney et al., 1998).

Trust is an essential component of online transaction behaviors. It reduces perceived risk and increases willingness to buy (Xu & Yadav, 2003). Pavlou and Gefen (2004) indicate that trust in the community of sellers has positive effect on transaction intentions, but significant negative effect on perceived risk of the seller community. Because buyers realize the effect of perceived risk, they are willing to compensate reputable sellers with price premiums in order to assure safe transactions. According to the definition of Ba and Pavlou (2002), price premium is the monetary amount above the average price received by multiple sellers for a certain matching product. They also find that trust of sellers has a positive effect on price premiums.

Feedback Mechanisms

Feedback mechanisms are used widely in online auction markets. They provide a place where users are able to leave comments about their buying and selling experiences and their evaluations of the buyers and sellers whom they perform the transaction with (Ba & Pavlou, 2002). They rank as positive ratings, neutral ratings, and negative ratings. Each rating equals a paired buyer-seller transaction. This mechanism allows buyers and sellers to rate each other following transactions and makes the history of a trader's past ratings public to the entire community (Dellarocas, 2003). Feedback mechanisms can be viewed as a reputation system or word-of-mouth network. It also encourages traders to behave well if they want long-run plays.

Prior researches have also shown that feedback mechanisms affect trust in Community of sellers (Pavlou & Gefen, 2004), and that trust in sellers has positive effects on price premiums (Ba & Pavlou, 2002). Strader and Ramaswami (2002) also indicated reputation of the seller as the most important factor in trust that affects online sellers' choices. Although we can't directly measure the effects of trust in the field data experiment of this research, prior study have suggested feedback mechanism as a proxy of trust. According to these researches, we can assume the effects of

feedback profiles and form the following hypothesis:

H1: Sellers with better feedback gain higher price premiums compared to sellers with worse feedback.

Product Characteristics

There are a big number of product items that are investigated by online auction researches. Resnick et al. (2002) summarizes 14 previous studies of product items, as shown in Table 1. Strader and Ramaswami (2002) chose baseball cards as their product sample. This does not, however, answer the question of whether or not different products result in different outcomes of research. Ba and Pavlou (2002) investigated the moderate effects of product price. They found that the relationship between trust and price premium is stronger in expensive products. It is unknown if there exist any other characteristics of product affect trust and price premiums. For example, previous researches focus on the search goods rather than experienced goods. By categorizing the product we realize there might be different in price premiums.

There are many ways to categorize the product. Nelson (1974) defined two types of goods:

- A good is a "search good" when full information for dominant product attributes can be known prior to purchase.
- A good is an "experience good" when either condition holds:
 1. Full information on "dominant" attributes cannot be known without direct experience.
 2. Information search for "dominant" attributes is more costly/difficult than direct product experience.

Table 1. Summary of previous researches (Resnick et al., 2002)

Citation	Item sold
Ba and Pavlou (2002)	Music, software, electronics
Bajari and Hortacsu (2003)	Coins
Dewan and Hsu (2002)	Stamps
Eaton (2002)	Electric guitars
Houser and Wooders (2000)	Pentium chips
Kalyanam and McIntyre (2001)	Palm Pilot PDAs
Kauffman and Wood (2000)	Coins
Lee et al. (2000)	Computer monitors and printers
Livinston (2002)	Golf clubs
Lucking-Reiley et al. (2000)	Coins
Melnik and Alm (2002)	Gold coins
McDonald and Slawson (2002)	Dolls
Resnick and Zeckhauser (2002)	MP3 players, Beanie babies
Resnick et al. (2002)	Vintage postcards

Figueiredo (2000) argued that the ability to judge the quality of a product is the biggest differentiator among product categories on the Web. He classified the product into four categories: commodity products, quasi-commodity products, "look and feel" goods, and "look and feel" goods with variable quality; however, look and feel goods with variable, like original art or used cars, is difficult to use to analyze the effect in online auction environments. We choose two types of goods as our product categories and investigate whether or not there are different outcomes between search goods and experienced goods.

H2: The relationship between trust and price premium is moderated by product characteristics.

III. Proposed Research Methodology

This study builds an intelligent agent to collect actual behavior data from Yahoo Auction. We choose Yahoo Auction as our sample due to that it is 16 times larger than the Taiwan eBay auction market.

Figure 2 illustrates the architecture of the agent system. We implemented the intelligent agent with Asp.net and Microsoft SQL Server 2000. As depicted in figure 2, the agent can respond for parsing required data gathered from the web page of Yahoo Auction website and then filter and store it in database for future analysis. We will employ multiple regression analysis to examine the relationship between feedback mechanisms and price premiums. Independent variables are the logarithm of the number of positive and negative ratings, and the dependent variable is the price premium developed by subtracting the mean price from the final price of each product divided by its mean price. It is expressed in equation (1).

$$\text{Price Premiums} = \beta_0 + \beta_1 \cdot \text{Log(PositiveRating)} + \beta_2 \cdot \text{Log(NegativeRating)} + \varepsilon (1)$$

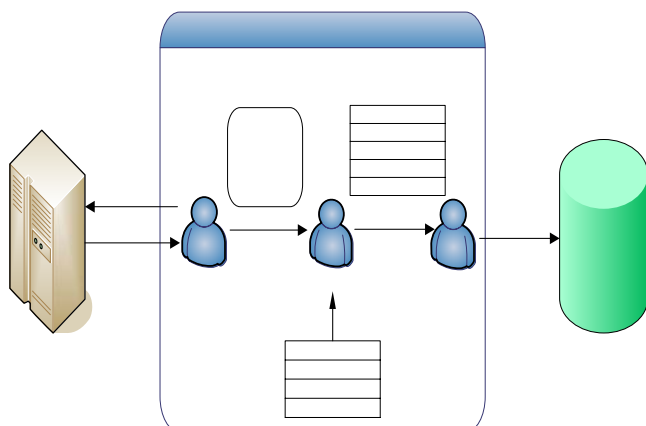


Figure 2. The System Architecture of Intelligent Agent

IV. Current State of Research

At present, the field data of Yahoo Auction bidders' behaviors is being collected. We will employ linear procedures in SPSS to approximate all parameters. By the time of the conference, we expect that the relationship between feedback mechanisms and price premiums will be fully explored. The fitness of equation and mediating effects of product characteristics will also be presented at the same time.

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Intelligent Agent

Yahoo! Taiwan
Auction Server

Html file
 <html>

Product Data
 ProductID a12345
 Money 100
 StartDate 9/26/2005

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Knowledge Modeling for Readiness Self-Assessment

Dunwei Wen^{1,2}, Ken Dickson¹, Fuhua Lin²

¹ Office of Vice-President Academic

² School for Computing and Information Systems
Athabasca University, 10011-109 Street, Edmonton
Alberta T5J 3S8, Canada

{dunweiw, kend, oscarl}@athabascau.ca

Abstract: Online readiness self-assessments are widely used in universities providing distant education, and they can help prospective students to understand the requirements and their readiness to study in these universities. Most of the self-assessment systems are Web-based static questionnaires. In this paper, a novel adaptive online self-assessment system AM I READY is introduced. The system is based on knowledge models, including static and dynamic user model, counseling model and self-assessment process model. It can dynamically filter questions to be asked to a specific user and adjust the contents of webpage dialog between the user and the system according to knowledge models and the user's responses. The system is more effective and helpful than the usual ones.

Keywords: E-Learning & Innovations in Teaching, Knowledge Modeling, Self-Assessment

I. Introduction

Online readiness self-assessments are widely used in universities that provide distant education service. The purpose is to help potential students to know the leaning style and requirement of studying as a distant learning student, and decide if the distant learning is the right choice for them. Most current readiness self-assessment tools are online questionnaires. By doing the questionnaires, potential students read some information and may get a final score related to their answers to these questions. The high score means high degree of their readiness. This kind of model is relatively simpler and needs to be upgraded in several aspects.

Actually, in this paper, we treat readiness self-assessment as a kind of counseling process. By doing so, we can analyze the counseling process to understand what should be done to upgrade the current model. The self-assessment system is functionally like a counselor, who needs to know the background information of his/her client (the user of the system) as early as possible and ask necessary questions to get more required information of the client until the counselor finally form an assessment about the client. During the counseling process, the counselor may also pick and/or skip some questions of all possible or potential questions according to the needs to logically understand the client by his/her answers to previous questions, and form a

more and more specific figure of the client and finally the assessment to the client about his/her readiness.

This paper describes our work to attempt fulfilling this upgrade based on this thought. As most of current systems adopted in other universities, the previous system of Am I Ready for Athabasca University is a self-assessment questionnaire: Am I ready for Athabasca University? It involves several self-test groups, including Goals, Preparation, Supports and Commitment, which are content-fixed or static (i.e. tests that do not adapt to the user's responses). Each of these groups is a Web-based questionnaire. The user can choose one of several options (Yes or No) for each question and finally get a score. The score reflects the total number of Yes and No answers, but is not objectively correlated with any measure of readiness for distance education. The students can get some information from the assessment according to the score and the meaning of Yes or No for each question. A lot of "No" answers may indicate the user needs to think more seriously about their decision before they begin their studies. The shortcoming of this system is that it does not help the prospective students very much to find out what are needed to succeed and how to get those needs met. Also, it can't dynamically alter the sequencing of questions according to user's answers in order to assess the student's readiness more precisely.

The new version of AM I READY for Athabasca University (AM I READY) is an adaptive online self-assessment tool for prospective students of Athabasca University. It is based on knowledge models of counseling process, including User Model, Counseling Model, Process Model and Assessment Model. It can choose and present most necessary questions to users by enabling, disabling and changing priority of questions according to those models, and produce dynamic question-answers dialog to a specific user. It involves better understanding of a user and effective self-assessment process with a smaller necessary question set. It can provide real time information to conduct users and show related resources to users to help them with more information. It can also find the contradictory answers of a user and give assessment according to all of the user's answers.

In the rest of this paper, the related work is reviewed right after the introduction, including adaptive questionnaires or assessments. The knowledge modeling of AM I READY system is proposed in the third section. Some details of User Model, Counseling Model, Process Model and Assessment Model are described there. In section four, the design and realization of AM I READY is

introduced. The last part of this paper is about the conclusion and future work.

II. Related Works

There are some related works about the adaptive questionnaire or self-assessment, and knowledge modeling currently. An adaptive Web-based questionnaire for course survey is developed and evaluated by Chou et al in [1]. It uses the answers to certain questions, which are called Adaptive Questions, to determine the next series of questions and to skip unrelated questions. Only few questions are Adaptive Questions in their question set. Unlike other questions, they only show one by one on individual Web page for the convenience to immediately decide and lead to other related question groups in the following page. This restriction does not exist in our AM I READY system, in which all kinds of questions are combined together and priorities are used to order or control the proper presentation of following related questions. Web-based online questionnaire can also acts as an online pupil consultation system according to Milne et al [2]. Three adaptive algorithms, including Skipping, Branching and Relevance Weighting Algorithms are analyzed and compared, and Branching Algorithm is finally used in the work to make it more effective and easier to use. An interface is designed for teachers to construct the questions, response and possible path of those questions. However, it is hard to define all possible paths if there is a larger question set and relations between those questions. Nokelainen et al [3] designed an adaptive questionnaire based on Bayesian Modeling. In their paper, Bayesian statistical techniques are used to create an individual learner's profile (in Profile Creation Phase) and optimize the number of questions presented to each user (in Query Phase). It is very suitable for such surveys or test applications that we only know few about their results and categories. But it is not fit for AM I READY project, where all possible relations between questions are coded and put to the knowledge base, because it needs more controllable and user specific self-assessment process. There are also many works about knowledge modeling recently. One of them, which is related to user-adaptive interface, proposed by Rosis et al, is a visual formalism and an evaluation tool, XDM, context-sensitive dialogue modeling, to model user-adapted interface based on extended Petri nets [6]. As to other application of self-assessment, it can also act as a self-learning system according to Gayo-Avello [4]. Another related field is Adaptive Testing [5], in which testing is adapted interactively to match the ability level of the examinee by means of a statistical method called "Item Response Theory".

III. Knowledge Modeling

Let's have a look at a real counseling process first. There are two roles involved: a counselor, who is the expert of the specific counseling field and the controller of the current

counseling process, and a client, who has his/her own needs and background information that the counselor needs to know during (and maybe before) the counseling process. The more information the counselor knows about the client, the fewer questions he needs to ask while trying to understand the client and then give an assessment to him/her. Respectively, there are several models built to support the adaptive self-assessment of AM I READY, namely, User Model, Counseling Model, Process Model and Assessment Model. User Model is the knowledge about the client, including static (produced before or at the beginning of the counseling process) and dynamic ones (produced during the process). We model the counselor by Counseling Model (related to field knowledge), Process Model (knowledge about the counseling process) and Assessment Model (knowledge about the assessment). All these models are showed in Figure 1.

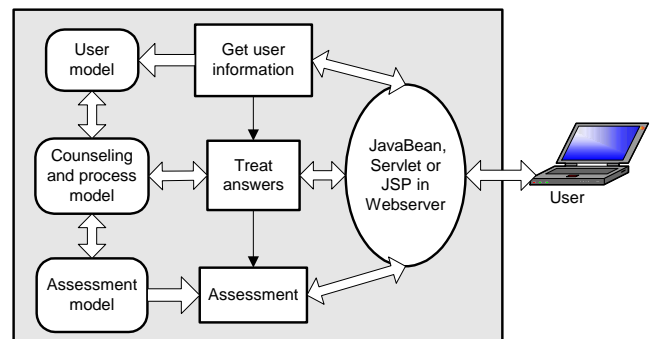


Figure 1. Knowledge Models and Architecture

User Model

There is lots of information about a user. However, we only need those that mostly affect the readiness self-assessment of the user. For this purpose, we chose several items about a user as the User Model parameters, namely:

- Highest level of education
- Work status
- Financial capability
- Computer skills
- Favorite questions groups

Users can make their choices at the very beginning of their self-assessment by clicking the options of these parameters. Figure 2 shows the Web page for building user model. The values of those model parameters directly affect the questions the system is going to ask later. For example, if a user tells the system that he/she has graduated from college or above, the system is not going to ask any questions to assess his/her readiness of basic writing skills. Two kinds of relations have been built into the model about what *questions* or *fields* are "Disabled", "Enabled" or "Plus"

priority by a specific value of a parameter. This is the *static* user model – they are not going to change during the assessment after they have been set. The inner representations are the parameters and their relations in the form of *Facts* and *Rules*.

The *dynamic* user model is essentially about the records of the user's choice history along the assessment, which is always changing during the assessment. The main items include the answer of each question, records of questions that are disabled, enabled, and have high priority. The increasing records will continue affecting the questions of the next page asked to users according to the same rules mentioned above.

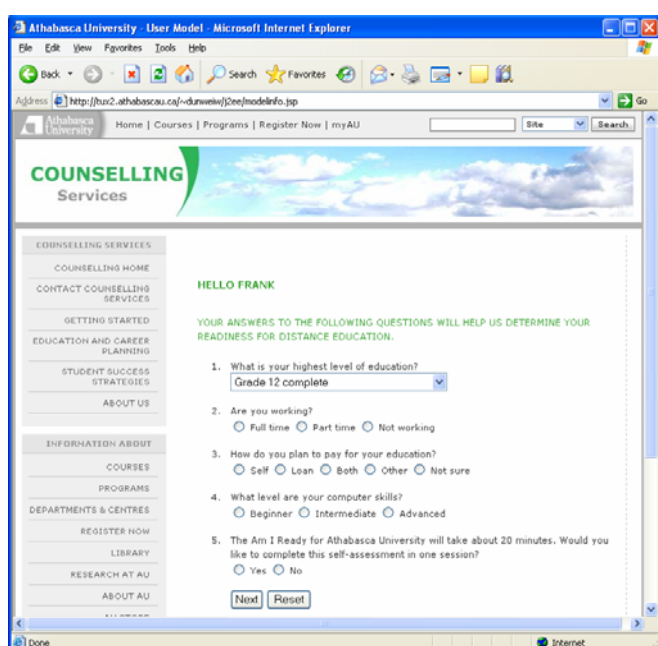


Figure 2. Static user model Web page

Counseling Model, Process Model and Assessment Model

Needless to say, counseling knowledge is always different in contents, forms and styles according to different domains and processes. However, we can still try to model the general level of the counseling knowledge, like the methods of counseling knowledge representation and resolution. In this part, we have captured five kinds of knowledge for AM I READY, which forms Counseling Model (*Questions*, *Relations*, and *Instant Information*), Process Model (*Process*) and Assessment Model (*Assessment*).

Questions are the knowledge sets about all questions of a system, its fields and sub-fields and predefined answer types. All questions are divided into eight groups (or fields) in AM I READY, e.g. Educational & Career, Financial Readiness, Academic Preparation, Course/Program Awareness, Commitment & Motivation, Computer Readiness and so on. Each field may have some sub-fields. Like that Financial Readiness includes four sub-fields, namely, General Information, Family Support, Loans and Awards. Each

question belongs to a sub-field and each sub-field belongs to a field, which forms a standard hierarchical tree structure. All questions are in plain text and can have predefined different kinds of answers. Currently, AM I READY has (1) Yes and No, (2) Yes, No and Not Clear, (3) Grade and (4) Multi-Checks. The last one can have multi-choices answers. Questions and related answer options can be seen in Figure 3. Users can choose their answers to those question by click related radio buttons. Even questions of Multi-Checks type can be represented by multi radio button pairs.

Instant Information is the additional information related to answers of certain questions. Users can see the instant information immediately after he/she click an answer button, as showed in Figure 3. The main purpose of instant information is to give users immediate response, and provide related resources (links or emails) and guidance to follow self-assessment process.

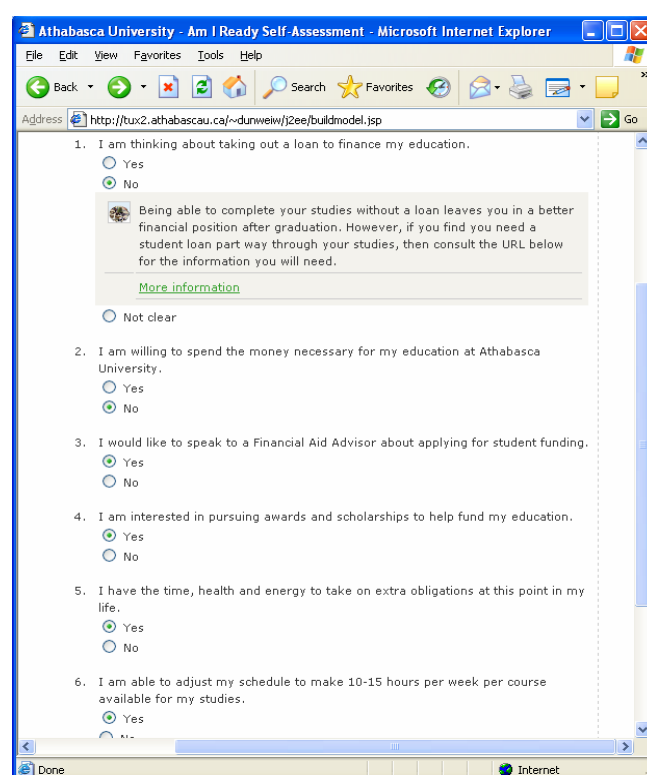


Figure 3. A self-assessment Web page

Relations include all relations between questions. We also regard them as rules. In AM I READY, relations can be question to question(s), question to sub-field(s), and the latter can finally become question to all questions belonging to the sub-field(s). So the relations are always one-many relations. There are four types of relations as briefly mentioned above, which are *Enable*, *Disable*, *Plus* and *Contradictory*. The first three relations are in this form:

(**Enable** (Answer(i) of question(j),
(question list)
(sub-field list)))

It means that an answer of a question will enable some questions or other questions belonging to some sub-fields if they have been disabled before. *Disable* relation can disable some questions that are no longer needed to ask the user according the user's current answer. *Plus* means to enable some questions and add the priority of those questions, which can cause those questions to be asked soon. The order to show questions is made by sorting those questions according to their priority. *Contradictory* means that some answers to certain questions are contradict:

(**Contradict** (Answer(i) of question(j),
(list of answers of some questions)))

Process is the knowledge of how to control the counseling process. To improve the effectiveness of a self-assessment, modeling the counseling process in a suitable way is very helpful. And it is also useful for AM I READY system to understand the process and make suitable or nature "dialog" between users and the system. To do this, we need to combine the process with other knowledge like user model and other counseling models. Just as what a real counselor is going to do, there are two critical methods: (1) *Adopting models* mentioned above, including user model and counseling model, (2) *Changing Priority* in real time and *Sort Questions* by their priority. By adopting user model and counseling model, AM I READY can filter, skip, gather questions, and by the help of priority handling, AM I READY can ask more related questions together, which is more natural to use and more friendly to interact. For example, after the user choosing Yes or Not Clear to the first financial question: "I am thinking about taking out a loan to finance my education." All detailed questions about the loan are going to show on the next Web page (see Figure 4). Not like [1], in AM I READY, every question can be an "Adaptive Question" and questions on next Web page are always most related to current answers. It gives the system great flexibility and produces a kind of flexible or dynamic "Webpage-Dialog". With the flexible filtering and skipping functions, AM I READY is more effective and suitable for applications with large set of question. On the other hand, by the help of these mechanisms, we don't need to be too serious about the questions set, if only we can tell and capture the relations of those questions.

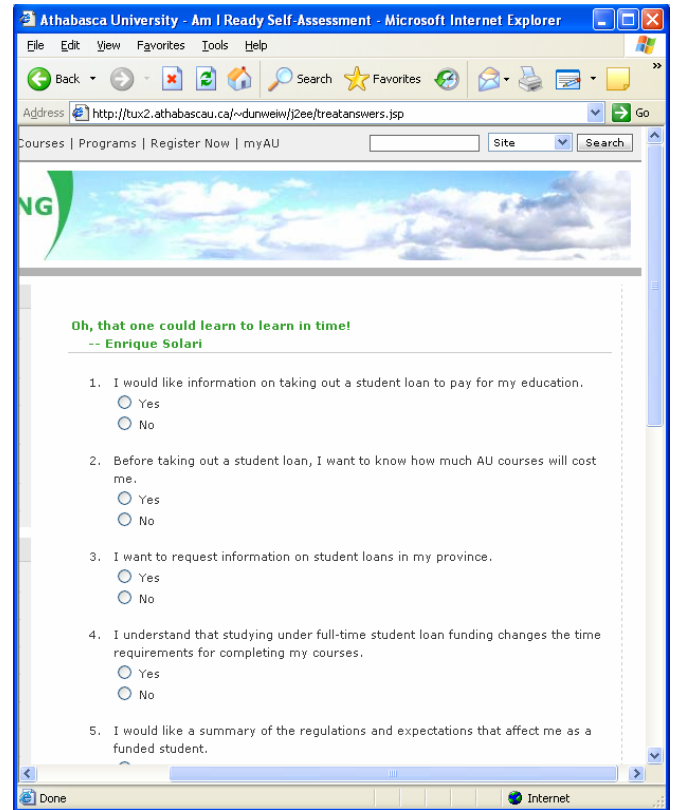


Figure 4. A dialogic Web page after Figure 3.

Assessment is information about the assessment sentences, which are going to show at the last page of the self-assessment. As mentioned in introduction section, we don't use a single score to assess the readiness of a user. Actually, some assessment information plus remedial suggestion are more useful to users, which can help them to understand how to make it happen if he/she is not so readiness in some aspects. We've designed two kinds of assessment information: *Question Related* and *Question Group Related*. The latter has more than one conditions coming from different fields and questions:

(Assessment (i) (3)
←
(answer(i) of question(j),
... ...))

The final assessment information is in Figure 5. Users can browser, download and print the assessment information in AM I READY system.

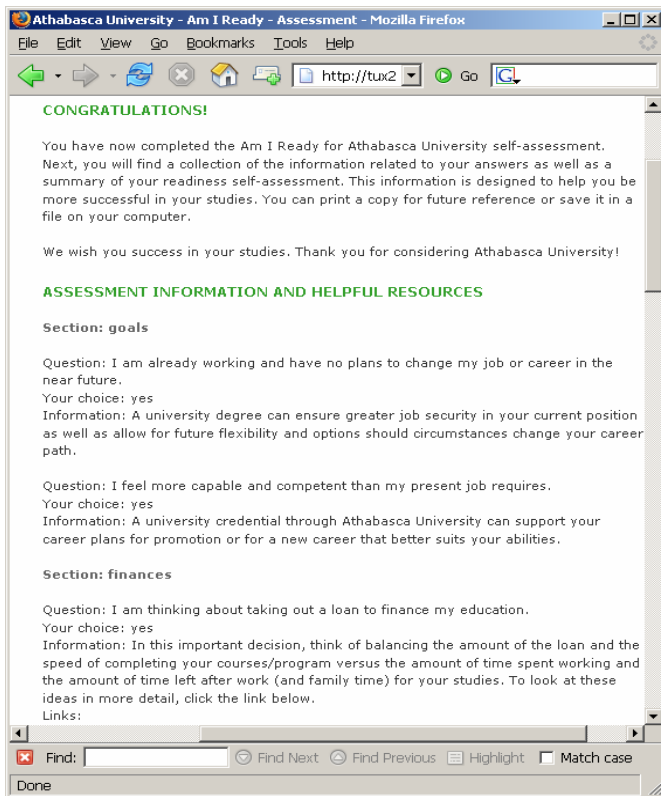


Figure 5. Assessment information

IV. System Structure And Realization

As mentioned above, AM I READY is a knowledge intensive system. We have modeled different knowledge with different representation. We can then use different expert or reasoning tools and methods to realize the self-assessment process. As it should be a stable and sustainable system serving to online users, and should be compatible with current information infrastructure of Athabasca University, we've tried to put the knowledge, including rules, relations, facts and text information, into PostgreSQL database, and to reason the questions to ask next by SQL and Java/JSP. The system structure is depicted in Figure 6, and the overall counseling or self-assessment process is depicted in Figure 7.

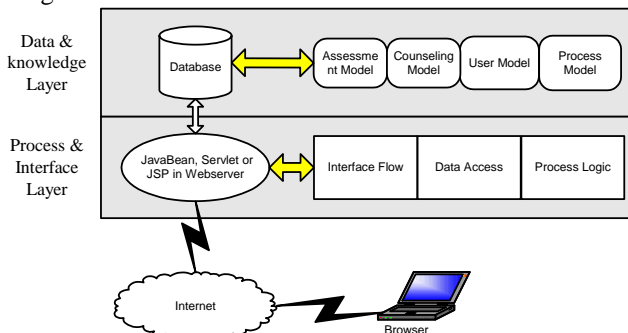


Figure 6. System structure

The system can be functionally divided into two layers: Data & Knowledge Layer, and Process & Interface Layer. All the data and knowledge are stored in the first layer with the help of database and SQL reasoning, while Java/JSP on the second layer handles the interface and interaction between the system and users. Users can online access the system by the Internet.

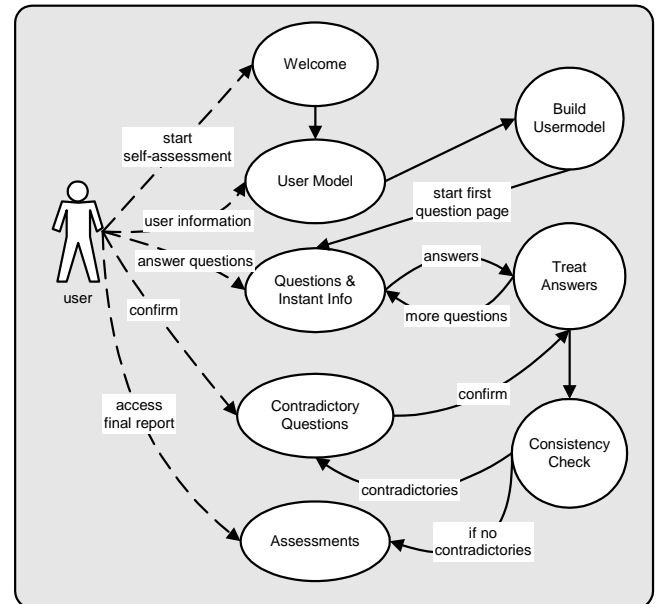


Figure 7. Information interactions among components

As you can see in Figure 7, a user can input user information at the beginning of the self-assessment. The system then builds the user model according to the inputted information. Based on the first filtered or arranged question sets, the system starts to ask questions and the user starts to answer those questions in turn. The system can ask new questions to the user after it accepts the user's answers and selects questions to ask by reasoning and sorting all currently available questions which are always changing to follow the direction to "model" or "understand" or "assess" the user. If there are no more questions to ask, the system is going to check answers to see if there are some contradictions among them. If yes, related questions are going to be sent back to the user for double check. After the contradictory questions has successfully confirmed, the final assessment information displays on the last page.

V. Conclusion and Future Works

Knowledge modeling in AM I READY project has captured different kinds of counseling knowledge and several models of self-assessment process, and has brought new features to traditional self-assessment online questionnaire system. Those features include flexible questions designing, user oriented or user specific questioning, dynamic and adaptive self-assessment process. Knowledge modeling, representation and reasoning have been proposed and implemented

in this project. Functionally, it provides a more effective and natural process to understand and assess its users. It can also provide real time guidance and remedial information to the users, which can be very helpful for the prospective students not only get to know their readiness, but also know how to improve the readiness.

The system is currently running and providing online services. However, we still have some work to do in the future. A knowledge editor is needed to improve the knowledge modeling and modification. A new change for improving the final representation of users' readiness by statistical information is on the way. A Formal knowledge description and a SQL based reasoning method for AM I READY are going to be reported in another paper. Data mining can also be done to analyze the questions and their relations and provide some information to improve the knowledge base. Readiness self-assessment is only the rudimentary step to a general counseling system, which we expect to intake more Psychology and Artificial Intelligence technologies to pursue the research and development on it.

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Assessing E-Learning Effectiveness: Developing Strategies for Pedagogy, Resources and Delivery

Indrit Troshani, Sally Rao
School of Commerce
The University of Adelaide
233 North Terrace, Adelaide, SA 5005
Australia
Email: {indrit.troshani, sally.rao}@adelaide.edu.au

Abstract: Although e-learning is spreading quickly across the globe in both educational and non-educational institutions there are problems and misconceptions related to e-learning. Thus, the aim of this paper is to review existing literature, particularly previous research pertaining to the three dimensions on the basis of which online courses should be designed and assessed. Essentially, we argue that e-learning should take a systematic approach and the checklist we have developed can be used to assess online teaching and learning sites and to develop strategies for pedagogy, resources and delivery in e-learning. It is hoped that introducing measurability of online course assessment will help quantify the usefulness of online course.

Keywords: E-Learning & Innovations in Teaching

I. Introduction

The aim of this paper is to review existing literature, particularly previous research pertaining to the three dimensions on the basis of which online courses should be designed and assessed. These dimensions include pedagogy, resources and delivery [20]. This is important because there is significant evidence in literature suggesting that although e-learning is spreading quickly across the globe in both educational and non-educational institutions there are problems and misconceptions related to e-learning [12,13,15].

As a result, the identified factors can be of significant help to educators who design online courses and who are involved in online teaching and learning. The identified factors are summarised as components of a checklist, which can be used to assess online teaching and learning sites. A method to validate the proposed checklist is then presented. Finally, limitations of the checklist and a future research directions to improve the checklists further are also identified.

II. Pedagogy Strategy and E-Learning

Pedagogy refers to the activities which underpin a learning environment [20]. There are three aspects to any pedagogy

namely, dependant/independent, structured/unstructured, and guided/open-ended, where each choice is independent of the other [47]. No single pedagogy suits all students and all courses. Consequently, educators may use more than one pedagogy in a course to provide variety in order to cater to the needs and abilities of different students.

Recent theory supports the notion that learners learn best in environments that are created from an approach that advocates situated learning which immerses them in an authentic, problem based, goal oriented, open ended learning environment and actively engages them, and uses collaboration in its constitution. In the case of online learning, this approach provides support from the lecturer in the form of coaching and scaffolding to facilitate knowledge construction and self regulated learning.

The use of the social constructivist approach is well documented as the preferred approach to online learning [18,20,28,35,43]. There are seven pedagogical goals that designers of constructivist learning environments should take into consideration [14]:

1. Experience with the knowledge construction process
2. Experience in and appreciation for multiple perspectives
3. Embed learning in realistic and relevant contexts
4. Encourage ownership and voice in the learning process
5. Embed the learning in social experience
6. Encourage the use of multiple modes of representation
7. Encourage self-awareness of the knowledge construction process

Through a constructivist approach, learners can create their own interpretations of the events around them and use existing knowledge and understandings, and construct their own new understandings from these interpretations [28]. As an extension of this, Social Constructivism [44] emphasises that the interaction of learners with others leads to cognitive development and supports collaborative construction of knowledge through social negotiation. There is agreement in the literature that that knowledge building results when learners interact with their peers, challenge their thoughts, beliefs, perceptions and existing knowledge by collaborating, discussing their positions, forming arguments, reevaluating their initial positions, and negotiating meaning [3,22]. The Internet in general and the World Wide Web support many different forms of communication that facilitates collaboration (e.g. online discussion boards, etc.) and should

be used in the online learning environment in a meaningful way relevant to the set tasks. Therefore, teaching and learning activities should be designed such that a smooth progression from socialisation through to information sharing and to knowledge construction can be made [5].

Expert advice can be provided to online students in many different ways, such as, feedback on work submitted, asking challenging questions, correcting misconceptions and through inviting practitioners and other experts to participate in online discussions. By participating in weekly discussions, commenting on students' contributions, adding comments and references that relate to the weekly topic tutors can both feed the discussion environment and guide their students playing a vital role in promoting consistent and relevant interaction between students and tutors [8,43].

Therefore, educators play a vital role in promoting consistent and relevant interaction with students. Their role as facilitator, virtual or online is crucial to the development of skills required for students to move from dependency on the e-moderator to self-directed learning. However, the educator should not be seen as an authoritarian figure, but rather as a coach and refrain from imposing (their) views on the discussion but carefully guide the students in exploring an issue through multiple perspectives [43]. By providing multiple perspectives or interpretations of reality knowledge can be further integrated into the learners' existing schemata. Thus, a variety of learning activities should be provided to accommodate different learning styles and life experiences of the learner [2,8,21].

Constructivists perceive that students construct different cognitive structures based upon their previous knowledge and interests. Consequently, learning tasks and activities should be centred around problems that have personal relevance to students [42,46]. Moreover, the way in which problems are introduced to the students is critical to the amount of buy-in by the students. The problem presentation needs to be interesting, appealing and engaging and simulates the problem in a context in which it is normally and naturally encountered as the context defines and structures the problem [36]. Problems that are situated in authentic, real world scenarios that are linked to the students own experiences provide an open-ended learning environment that is goal-oriented and often complex by nature. They arouse curiosity, engage the student, and encourage active participation [24-26]. Authentic learning is

active learning. It involves real life situations and problems that have context, depth, complexity and duration. They involve cooperative situations and shared consequences, are worth solving and can provide benefits when solved. They are comprised of a single sustainable complex task that provides the opportunity to look at different perspectives, promote reflection to enable abstractions to be formed and promote articulation to enable tacit knowledge to be made explicit. By providing relevant, problem-based, real life scenarios the learning is situated in the problems that are being solved.

An online learning environment should provide opportunities where the student can actively manipulate available functionality in order to facilitate learning and reflecting [24-26,34,45,46]. This metacognitive process should be facilitated by the teacher who should provide guidance and support in the knowledge construction process with the provision of flexible scaffolding where the instructional design and teaching tactics surround, but do not fill in, the learning by students [20]. This support should be provided in the initial stages and it should be gradually removed as students increase responsibility for their own learning and become more self-directed. Nevertheless, interactions with the lecturer should always be the centrepiece of education, no matter what the medium [27].

The identification and articulation of aims and objective in e-learning is important as it provides the foundation for the instructional design, development, delivery, and assessment of an educational event [19]. These aims and objectives should form part of the teaching and learning plan as they predetermine what is to be taught and learned. Consequently, it can be expected that e-learning activities will equip students with the necessary skills, knowledge, and experience to meet the aims and objectives of the course.

In addition, assessment points throughout the course should reflect the educational growth of the students. Continuous assessment is important for both teachers and students because it provides information on the progress made, it helps measure the accomplishments of learning objectives, while also providing students with benchmarks for monitoring their progress and means of adjusting their learning tactics. Therefore, assessment and measurement strategies should be integral parts of the learning process.

To summarise, we propose the following pedagogy strategy checklist for e-learning:

Authentic tasks:

- | | | |
|-------------------------------------------------------------------------------|-----|----|
| • Tasks have a clear purpose | Yes | No |
| • Activities are problem based using real world scenarios [situated learning] | Yes | No |
| • Activities are authentic to the environment in which they are used | Yes | No |

Opportunities for collaboration

- | | | |
|---------------------------------------------------------------------------------------------|-----|----|
| • Activities create opportunities for learners to interact meaningfully | Yes | No |
| • There are opportunities for interaction between student and tutor | Yes | No |
| • Guidance is provided to ensure collaboration is meaningful and relevant to the set tasks. | Yes | No |
| • The tutor promotes consistent interaction | Yes | No |

• Activities support peer tuition and/or assessment	Yes	No
• Activities make provision for industry mentors	Yes	No
<i>Learner-centred environments</i>		
• Activities actively engage the learner	Yes	No
• Problems are complex	Yes	No
• Problems are encourage active participation	Yes	No
• Tutor provides guidance or scaffolding where appropriate	Yes	No
• Learning is based on inquiry or problem-based tasks	Yes	No
• Instructional activities should encourage and required students to actively participate in the acquisition and processing of educational content.	Yes	No
• Activities support and develop students metacognitive skills	Yes	No
• A variety of learning activities are provided to accommodate different learning styles and life experiences of learners.	Yes	No
<i>Engaging</i>		
• Activities and assessments are linked to learners own experiences	Yes	No
• Activities arouse curiosity and are interesting	Yes	No
• Problems are contextualised and complex	Yes	No
<i>Meaningful Assessments</i>		
• Evaluation of performance is directed toward the measurement and assessment of the predefined learning goals and objectives.	Yes	No
• A variety of "low-stakes" assessment and measurement strategies are provided to enable students to gauge their progress without impacting on course grade or performance measurement	Yes	No
• Automated systems (e.g. on-line quiz tools) are provided for immediate feedback, relevant suggestions, and guided support in response to learners' performance.	Yes	No
• Asynchronous technologies such as electronic mail, bulletin boards and/or other technologies support the assessment and measurement activities.	Yes	No
• Opportunities for students to provide feedback regarding the instructional design of the program.	Yes	No

III. Resource Strategy and E-Learning

One of the important aspects that the educational design of an online unit needs to take into consideration includes the resources that are provided to the learners [20].

Accessibility. Firstly, accessibility is an indication of the ease with which learners are able to locate and access information resources provided by the online unit [38]. Accessibility of online resources by people with disabilities is similar to the accessibility of online resources by non-disabled people that browse in non-standard conditions, such as outdoors, on-the-move, or through devices with limited capabilities [31-33,39].

One of the accessibility rules is the separation of unit contents from the sites appearance. This means that online learning sites should provide users with the capability to override defaults styles with user-preferred styles [1,39]. This should reflected in site design principle that sites should allow for customisation based on user preference. That is, the site should allow for versatility of the way information is presented (e.g. display changes, timing events, etc.).

Another rule is the provision of text alternatives for visual components (images and multimedia features). This

rule is important to accommodate access for learners who cannot afford suitable browsers or Internet connections [39] which can be accomplished by developing sites that are compatible with assistive technologies (ATs) and complete keyboard access.

The contents of the resources provided to the learner should also be given the due attention (Vrasidas & McIsaac 1999). The content structure of an online unit should be sufficiently detailed and meaningful in order to modularise the contents into small manageable chunks [43]. The level of detail and modularisation, however, should not interfere with the organisational logic, clarity and intuition of the provided information. Moreover, users should be allowed to easily navigate through the site hierarchy to retrieve what they require. Therefore site maps and advanced search capabilities, context and orientation information, navigation aids, etc. may be provided to assist easy navigation [1,31,33].

Standardisation. A related issue is learning content standardisation (Hodgins & Conner 2002) which should be based on accredited content libraries or learning management systems with the goal to reuse, transfer or have interoperability between learning systems. It is claimed that learning content standardisation will help answer questions like:

- How will one mix and match content from multiple sources?
- How will one develop interchangeable content that can be reused, assembled and disassembled quickly and easily?
- How can one ensure that one is not trapped by vendor's proprietary learning technology?

Examples of standards to help answer questions like the above include the IEEE Learning Technology Standard Committee, Advanced Distributed Learning Initiative, Instructional Management System (IMS) Global Learning Consortium, Education and Training in European Society (PROMETEUS), etc [1,21,31,33,38,40].

In this context, online sites need to provide content management tools, like authoring tools for course development and revision (Belyk, Schubert, & Baggaley 2002). They also should contain student management tools like password-protected logins, registration and withdrawal procedures, and other general student tracking functions. These functions will increase the flexibility, extensibility, interoperability, multicultural and multilingual support, etc. with which the provided resources are managed [4,17,31,33,38].

Useability. Useability is not only based on a set of best practice principles developed by Jakob Nielsen but also comprises a new principle according to which the content of an online learning web site should be matched to its audience [40]. This means that the target audience should be the determinant factor to define the communication style of the website. Specifically, Smulders (2001) argues that e-learning websites should steer from jargon and culture-specific perspectives. This, however, appears to be at odds with Herrington et al.'s (2001) guideline of resource inclusivity which suggest that resources should include a variety of cultural perspectives, where possible [17,31,33,38,43].

Another aspect of Smulders' (2001) useability notion includes content organization adherence to consistency and observance of tried-and-true standards. The rationale behind this is to systematically standardise website look and feel by making learning sites more predictable environments in order to allow learners to know what to expect. This aspect of Smulders' (2001) useability appears to be supported in [23,31,33,38] too.

To summarise, we propose the following resource strategy checklist for e-learning:

Accessibility of Resources

- | | | |
|------------------------------------------------------------------------------------------------------------------------------------------|-----|----|
| • The online site separates unit contents from the sites appearance | Yes | No |
| • The online site offers text alternatives for visual components (images and multimedia features). | Yes | No |
| • The online site offers auditory contents alternatives for visual components (images and multimedia features). | Yes | No |
| • The online site offers keyboard access options to all features. | Yes | No |
| • The content structure of the online unit is sufficiently detailed. | Yes | No |
| • The content structure of the online unit is sufficiently meaningful. | Yes | No |
| • The content structure of the online unit is logically organised. | Yes | No |
| • The content structure of the online unit is clear and unambiguous. | Yes | No |
| • The content structure of the online unit is intuitive and easy to follow. | Yes | No |
| • The contents structure of the online unit is based on tried and true standards. | Yes | No |
| • The resource have the learning content metadata feature in order to allow quick and advanced search capabilities of material provided. | Yes | No |

Standardisation of Resources

- | | | |
|--------------------------------------------------------------------------------------------------------------------------------------------|-----|----|
| • The learning content is sufficiently standardised to allow to easily mix and match from multiple sources. | Yes | No |
| • The learning content is sufficiently standardised to allow one to develop interchangeable content that can be reused easily and quickly. | Yes | No |
| • The learning content is sufficiently standardised to allow that users are not trapped by vendor's proprietary technology. | Yes | No |
| • | Yes | No |

Modifiability of Resources

- | | | |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|----|
| • The online learning site contains contents management tools allowing contents changes to be flexibility. , extensibility, interoperability, multicultural and multilingual support, | Yes | No |
| • The online learning site contains contents management tools allowing contents changes to be extensible. | Yes | No |
| • The online learning site contains contents management tools allowing contents changes to be provide for multicultural and multilingual support. | Yes | No |

Inclusivity of Resources

- | | | |
|---------------------------------------------------------------------------------------------------------------------------------------|-----|----|
| • The resource in the online learning web site are matched to all possible audiences, or provisions for different audiences are made. | Yes | No |
| • | Yes | No |

Richness

- | | | |
|-------------------------------------------------------------------------------------|-----|----|
| • The subject matter resources provide for multiple views on the subject matter. | Yes | No |
| • The subject matter resources encourage critical appraisal of what is available. | Yes | No |
| • The subject matter resources encourage empirical evaluation, where possible. | Yes | No |
| • The subject matter resources encourage creative thinking based on existing works. | Yes | No |

Currency

- | | | |
|--------------------------------------------------------------------|-----|----|
| • The resources contain seminal works on the subject matter. | Yes | No |
| • The resources contain recent developments in the subject matter. | Yes | No |

IV. Delivery Strategy and E-Learning

The ways in which an online course is delivered to students need to be anticipated in its design to ensure its quality [20]. As students come with a variety of backgrounds and technology experience, an online course needs to cater to these differences to ensure each student becomes involved in the learning experience in their own terms. The site should be reliable and have a robust interface that provides the student with a sense of adventure while being motivating, a confidence in tackling the technology, and support their efforts for knowledge acquisition without any barriers.

Online courses, should not be restricted to one delivery platform and should be flexible and easily customisable based on the following characteristics:

- use of software that is readily available;
- use code that can be customised easily and the use of development software for more sophisticated usage (eg Flash) for components that will not change;
- the development of resources that can be used in various delivery platforms;
- site structure that allows a student to progress through the learning material in a variety of pathways;
- site can be extendable and scalable.

The technology should be transparent to the student (Herrington et al (2001)). The layout and navigation should be clear and follow one's common sense. Therefore, sufficient technical instructions should be provided to assist students in the use of the site or details of how to obtain, support and assistance, e.g. technical help desk, student administration and other support services. An online learning site should be created with students in mind. Assumptions should be made that students do not have a high degree of technical expertise.

Influences affecting interface design that should be considered include: usability testing to gauge user

comfort/connectedness; user control/user centredness so that users can control their learning pathway and the activities are linked to their learning requirements; the interface design is consistent with the content structure; and the interface design supports the learning approach; and the interface provides for the students' individualised needs [37].

Online learning sites should provide students with clear goals, directions and learning plans and relationships should exist between learning outcomes, resources, activities and assessments (Herrington et al (2001)). The literature is consistent that the following should be unambiguously displayed in an online learning site:

- a unit outline that provides students with the aims, objectives, learning outcomes and learning approach used;
- the interaction required – details and times ;
- assessment – criteria, quality elements, length and weighting;
- texts (where the purchase and costs), references and websites – include textbook chapters, articles to consult, supplementary readings;
- suggested study schedule;
- links to student support material – eg institution handbook, student portal, learning centre, technical helpdesk;
- information written in greater detail so that the student can proceed independently or with need for little clarification by teaching staff;
- contact details (email, phone and fax) – teaching staff as well as student support areas.

As indicated earlier in the paper, knowledge building occurs through interaction with other students. Consequently, in an online environment, opportunities need to be provided for students to communicate with each other and their teacher. A variety of way can be used to accomplish this: asynchronous interaction, synchronous interaction and email. Asynchronous interaction enables students and teachers to participate in online forums where the entire learning community can partake in scholarly exchanges of mutual

benefit [9]. Synchronous interaction enables students to participate in real time interchanges that provide students with an immediate response to questions or comments. Email communication is useful for interchanges between the student and their teacher such as the student requesting assistance of a personal nature. Alternatively, email can also be used when the teacher advises feedback and grades, administration issues etc. (Chellman & Duchastel; 2000). Therefore, the learning channels should be open to all students, and encourage collaborative learning and knowledge construction.

When delivering e-learning bandwidth considerations should also be made. Bandwidth is defined in the literature as the amount of data that can be carried in the unit of time. Bandwidth considerations are important because they affect download times which also depend on connection speed for file size. Different students might have access to different types of network or Internet connections, therefore, the delivery of the online materials is likely to be affected [31,33]. For example, narrowband internet connections would be limited to [6]:

- Provision of materials – text, stills, limited low quality video
- Interaction with materials – text, stills, low quality video
- Interaction with teacher – email, chat, online discussion, low quality streaming
- Interaction between students – email, chat, online discussion, low quality streaming

Whilst broadband internet connections would offer [6]:

- Provision of materials – text, stills, video streamed from server (quality dependent on bandwidth)

- Interaction with materials – text, stills, high quality video
- Interaction with teacher – email, chat, online discussion, streaming (depending on bandwidth)
- Interaction between students – email, chat, online discussion, streaming (depending on bandwidth)

Students undertaking online learning should also be provided with recommended requirements for undertaking the online course. These requirements include minimum hardware and software specifications, internet connection, additional plug-ins as well as the details of how such plug-ins should be obtained. Online learning materials which are too large for downloading over the internet should be delivered to students via alternative means (e.g. CD-ROM mail-outs etc.)

An online learning site should also ensure equitable access by by vision and hearing impaired students. Therefore, the design of the websites should comply with W3C Web Content Accessibility Guidelines 1.0 (<http://www.w3.org/TR/1999/WAI-WEBCONTENT-19990505/#Guidelines>). Designers of online learning sites should also ensure that local standards are met. For example, in Australia, online learning sites should comply with EdNA (Education Network Australia). Metadata standards should “support interoperability across all sectors of education and training in Australia in the area of online resource discovery and management” (<http://standards.edna.edu.au/metadata/>). In addition, copyright materials that are made available online for educational purposes must comply with the Copyright Act 1968, which imposes obligations regarding the electronic communication of Copyright material. To summarise, we propose the following delivery strategy checklist for e-learning:

Reliable and robust interface:

- | | | |
|----------------------------------------------------------------------------------------------------------------|-----|----|
| • Content can be created using software that is readily available. | Yes | No |
| • Content can be used with other delivery platforms. | Yes | No |
| • Site is flexible and can be updated for currency/changed easily. | Yes | No |
| • The use of html code can be customised easily. | Yes | No |
| • The use of development software for more sophisticated usage (eg Flash) for components that will not change. | Yes | No |
| • The site structure allows a student to progress through the learning material in a variety of pathways. | Yes | No |
| • Layout and navigation is clear . | Yes | No |
| • Site has been created with students with little technical experience in mind. | Yes | No |
| • Useability testing has been undertaken. | Yes | No |
| • The interface supports the learning approach taken for this unit. | Yes | No |
| • The interface is consistent with the structure of the unit. | Yes | No |
| • The interface enables the students to complete their learning requirements. | Yes | No |
| • The site provides access or details about support and assistance available to students. | Yes | No |

Clear goals, directions and learning plans:

- | | | |
|------------------------------------------------------------------------------------------------------------------------|-----|----|
| • Unit outline is available that provides student with aims, objectives, learning outcomes and learning approach used. | Yes | No |
|------------------------------------------------------------------------------------------------------------------------|-----|----|

• Details are provided about interaction required of students.	Yes	No
• Details are provided about assessment including criteria, quality elements, length and weighting.	Yes	No
• Details are provided about texts, references, websites and other sources of information.	Yes	No
• A suggested study schedule is provided.	Yes	No
• Links to student support material are provided (eg administration, helpdesk, learning centre etc.).	Yes	No
• Information provided for the online student has been written in greater detail.	Yes	No
• Contact details have been provided for teaching staff as well as student support areas.	Yes	No
• Students have choices in the resources they use from the site.	Yes	No
• The site is not wholly based on content as a resource for learning.	Yes	No
• The site provides facilities for the student to interact with their learning.	Yes	No
Communication:		
• Communication is used to encourage active and collaborative learning and knowledge building.	Yes	No
• Provision is made for students to interact with the teaching staff and other students.	Yes	No
• Students are provided with email facilities or email addresses of teaching staff and other students.	Yes	No
• Students are provided with asynchronous discussion facilities.	Yes	No
• Students are provided with synchronous discussion facilities. (<i>Optional</i>)	Yes	No
Technical issues:		
• Technical instructions/support are readily available.	Yes	No
• Site can be assessed via an internet connection using a 28Kkbps modem.	Yes	No
• The site does not use large files for streaming video, online simulations and multimedia that distract or hamper the learning experience.	Yes	No
• The site can be viewed using a standard internet browser.	Yes	No
• Access or details about additional plug-ins the student may require has been provided.	Yes	No
• Details have been provided to students about the recommended requirements for undertaking the online unit (eg. minimum hardware and software requirements).	Yes	No
• Students have access to offline content (eg CD-Rom with large video or audio files; hard copy print based reader). (<i>Optional</i>)	Yes	No
Equity, accessibility and legal requirements		
• Unit materials and activities are available and are accessible by all students especially disabled students.		
• Site complies with the W3C Web Content Accessibility Guidelines.	Yes	No
• Site has been put through the Bobby tool to ensure web accessibility guidelines have been met.	Yes	No
• Site complies with EdNA (Education Network Australia) Metadata Standards.	Yes	No
• Site complies with the Copyright Act 1968.	Yes	No

V. Proposed Methodology

In the previous sections checklists assessing the effectiveness of online learning sites were proposed. In their current form, these checklists are based on current e-learning literature alone. For them to have practical value, empirical validation is required. We propose that validation should be carried out in two stages. In the first stage popular online learning sites will be reviewed in an attempt to enrich the

current checklists or identify items which are not supported. With the second stage, we believe that focus groups with students and educators are appropriate as a means of further validation. Focus groups allow for group interaction and have the potential to generate synergistic effects and, therefore, can produce data and insights which would otherwise be less accessible [7,10,11,16,29,30,41]. This, we believe, will enhance the quality of the data.

VI. Conclusions and Future Research

The checklists recommended above constitute an attempt to comprehensively and effectively assess online course for teaching and learning. As online teaching and learning becomes more popular and is used for teaching various fields of knowledge there is a growing need to standardise pedagogies, resources and delivery strategies which constitute the three most important components of online learning. In addition, with an increasing number of course delivered online less ambiguous assessment is required. In this paper, we have developed checklists which assess the three components of online learning.

Further research needs to be conducted in order to determine the relative importance of the proposed checklist items. This is important because the current checklists weigh all items equally. The reviewed literature indicates that certain checklist items may be more important than others. In addition their importance may vary for online courses of different fields of knowledge. Once determined, the relative importance of the checklist items may be quantified in terms of weights. The assessors of online course may then rate each checklist item depending on the assigned weight, to obtain a final score. Different online courses may then be compared on the basis of the calculated score. It is hoped that introducing measurability of online course assessment will help quantify the usefulness of online course.

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Consensus of Corporate E-Learning System Stakeholders Regarding the Satisfaction of End-Users

Jae-Sik kim¹, Hee-Dong Yang², Hye-Mi Um³, Hye-Seung Kang⁴,

¹ Samil pricewaterhouseCoopers, Seoul, Korea

Tel: +82-2-3781-9570 e-Mail: jskim@samil.com

² (Corresponding author) College of Business Adimin, Ewha Womans University, Seoul, Korea.

Tel: +82-2-3277-3582 e-Mail: hdyang@ewha.ac.kr

³ College of Business Adimin Ewha Womans University, Seoul, Korea

Tel: +82-2-3277-2777 e-Mail: nabiran@ewhain.net

⁴ College of Business Adimin Ewha Womans University, Seoul, Korea

e-Mail: gogodream@chol.com

Abstract: The purpose of this study is to call attention to the consensus of stakeholders of corporate e-Learning system regarding success. We identified the critical success factors (contents, technical features, management, and organizational support) as major components of corporate e-Learning systems and questioned whether stakeholders' consensus on the importance of these components facilitates the implementation of these components to achieve good quality or well. We also questioned whether the influence of these components on user satisfaction could be moderated by contextual factors. Based on empirical testing of 18 e-Learning user companies, we verified that the consensus of stakeholders regarding the importance of content, technological features, and organizational support has a positive influence on the perceived quality of these factors in their e-Learning systems, which in turn is positively related to user satisfaction. The learning subjects and learning style did significantly moderate the influences of these perceived qualities on user satisfaction.

Keywords: e-Learning system stakeholders, consensus of stakeholders, e-Learning user satisfaction.

I. Introduction

Online education systems (or e-Learning systems) have presented possible solutions for many problems arising from off-line-based education and training, such as temporal and spatial limits, and the distinctive benefits unavailable from traditional education systems such as agile updates of content, personalization, interactivity, and timeliness[5]. However, opinion is getting stronger among scholars and practitioners in the human resources development field that we need to be more clearly aware of the diverse views of stakeholders on education and training that can cause either chaos or consistency in the overall structure and efforts of education and training systems [22]. Thus, this study poses the following research questions:

-Who are the stakeholders that render substantial influences on the quality of corporate e-Learning systems?

-What kinds of factors influence the end users' satisfaction with corporate e-Learning systems? Also, are their influences stable or subject to contextual factors?

-What is the role of stakeholder consensus on the quality of such influential factors?

To answer these questions, first we reviewed how previous studies in management approached and investigated the issues regarding stakeholders and then identified three different groups of stakeholders who render substantial influence on corporate e-Learning systems. Second, we explored diverse literature on traditional learning, e-Learning system, and information system (IS) implementation to come up with a list of the influential factors pertaining to end-user satisfaction with e-Learning systems. Third, we developed measurement scales to assess the degree of consensus of the stakeholders regarding the importance of these influential factors and empirically tested how such consensus relates to the quality of implementation of the factors and eventually end-user satisfaction with e-Learning systems.

Further, this study presumes that the effects of these influential factors are susceptible to moderating variables instead of being steady and stable across diverse learning contexts. This study investigates whether the learning subjects and learning style moderate the effects of various influential factors on end-user satisfaction regarding corporate e-Learning systems.

II. Theoretical Framework

II. 1 Stakeholders of e-Learning Systems and Their Consensus

Freeman (1984) [11] defined stakeholders as individuals or organizations that make influences on or are influenced by a company to achieve its goals. Because stakeholders can influence organizational behaviors, decision-making, policies, and goals, companies need to divide the stakeholders into small groups with the same interests and deal with individual idiosyncrasies and demands with each stakeholder group [11]. Recognizing and reflecting the diverse perspectives of stakeholders must be a working strategy to increase cooperative attitudes among stakeholders, reduce risks stemming from stakeholders'

power abuse, and thus predict and control stakeholders' behaviors. Such lessons to relate to cooperative relationship with stakeholders have substantial significance on company education activities: i.e., recognizing all the diverse perspectives of stakeholders in education and training clearly [22]. Although researchers have diverse opinions about the components and stakeholders of e-Learning systems, practitioners and academia in Korea have agreed to classify the stakeholders of corporate e-Learning systems into **learners, e-Learning service providers, and human resource departments in charge of corporate education**. This study focuses on corporate e-Learning systems.

As previous studies on corporate e-Learning stakeholders are not abounding, we conducted in-depth interviews with e-Learning content developers, producers, service providers, and human resources development officers as well as individual users of e-Learning user companies, and asked all groupings whether the above three categories of stakeholders of e-Learning systems were valid. Through their agreement in this study, we come to confirm the three groups of stakeholders for corporate e-Learning systems.

This study is interested in the role of the prior consensus of stakeholders on the important factors that apply to their corporate e-Learning systems. Our posture is that high consensus among stakeholders on the importance and value of critical success factors of e-Learning systems facilitates actual implementation of those factors in good quality, which in turn leads to user satisfaction. Each stakeholder can also have unique critical issues that are not relevant to other stakeholders (for example, market share of e-Learning system products may matter only for the e-Learning service provider). However, the objective variable of this study is end user satisfaction, and therefore, the influential factors in the study are all limited by their relevancy to end-user satisfaction with e-Learning systems.

Our inference about the role of stakeholders' consensus on the ultimate qualities of e-Learning systems is based on the previous studies that have attributed the success or failure of organizational activities to a consistency and consensus in values, opinions, and significance of organizational stakeholders [24]. The importance of stakeholders' consensus has been highlighted by the theory of "group mind" for the last ten years. Several terms have been used to explain the process in which individuals form a collective sense for their teams, organizations, and environments, and emphasize the importance of agreement or consensus among group members. Particularly, the shared mental model is one of the most widely used terms [18]. The shareness of individual mental models is desirable for team performances because team members can form similar predictions for tasks, acquire the necessary information to complete them, and better adapt to the requests and issues of other teammates [4]. These previous studies insinuate that consensus of stakeholders regarding the importance and value of critical success factors for e-Learning systems can improve the possibility of implementation of those factors

and their qualities as well. Thus, what aspects of corporate e-Learning systems do the stakeholders need to appreciate and acknowledge in common to achieve this goal?

II. 2 Influential Factors for the Success of e-Learning System

We examined diverse literature of information systems and education engineering as it regards corporate education, e-Learning, and e-Learning systems in order to identify the influential factors for corporate e-Learning systems. More attention was needed for information systems because new technical features are being continually imported to e-Learning systems, such as Internet, graphics, animations, sounds, images, and color videos. Through the literature review, we agreed on the following four categories of influential factors that produced the success of corporate e-Learning systems: Content, technical features, management (of service providers), and (end-user) organizational support.

Keegan (1986) [15] emphasized the importance of lecture **content** in education. Keegan (1986) [15] and other constructivists proved that the content of multi-media education systems should be valid [17], well-structured [25], and clear and straightforward [23] for good performance and results. Thus, the learning experience can be varied according to how the different learning content is selected, structured, and expressed.

Howell & Silvey (1996) [12] indicated that the performance of multi-media training is deeply related to its **technical characteristics**. The representative metrics include the robustness and trend updates of technical features [21], convenience of system usage [7], and the speed and accessibility of the network [9].

Motivation and interaction are in the realm of e-Learning **management** of education and training service providers that support, encourage, and facilitate learners to continue learning [1]. Keller (1984) [16], who developed the ARCS (Attention, Relevance, Confidence, Satisfaction) Model for motivation development, contended that motivation and feedback are two major factors to obtain effective information system-based education.

Organizational support can be psychological (such as encouragement, recognition, and positive expectations of colleagues, bosses, and management) or materialistic (such as compensation and rewards based on performance of the learners) [1]. Doll (1985) [10] compared the organizational support between successful and failure IS-based education systems and found that successful systems are accompanied by substantial support from top management.

II. 3 Moderators of e-Learning Systems

Through intensive interviews with numerous e-Learning stakeholders, we sensed that e-Learning service providers and human resource departments consider the characteristics of learning subjects in preparing e-Learning programs. They determined different requirements of course load and pre-requisites for learners and different caliber levels and

qualifications for instructors. In addition, structuralism in education has mandated that the diverse learning styles of learners possess different preferences, requirements, and priorities for different learning systems.

The **subjects** of organizational education can be classified into hard and soft skills [20]. Hard skills relate to such issues as information technology, software operations, product knowledge, and task operations, all of which need to be well defined, structured, and closely related to current tasks. Soft skills denote knowledge that cannot be easily articulated or explained, such as personal relationships, courtesy and manners, interview tactics, ethics, and leadership. So far in Korea, e-Learning programs of most companies have been focused on hard skill contents; however, soft skill subjects are steadily increasing. Therefore, this study examines whether the learning subjects moderate the effects of those influential factors mentioned above on user satisfaction with corporate e-Learning systems.

Studies have identified that individual attributes, such as cognitive ability, experience, motivation, attitude, values, and expectation, are deeply involved with the overall effectiveness of traditional corporate educations [19]. Such attributes also exert significant influence on information system-based learning systems [8]. Particularly, we examined individual **learning styles** that possessed the preferences and requirements to complete each course. Due to this innate foundation, we need to identify the role of learning styles on learning and education performance. We propose that e-Learning style correspond to the usage type of decision support systems developed by Inmon et al. (1999) [14] because e-Learning systems require similar interactions to DSS in terms of cognitive challenge and purpose of use. We came up with a binary category for learning style: Exemplary type and whimsical type. These two respectively correspond to the farmer type and the explorer type of Inmon et al. (1999) [14] DSS usage categories of learning type. The exemplary type regularly uses e-Learning systems, clearly recognizes the goals of study, and focuses on the contents delivered through the system. The whimsical type does not regularly access the e-Learning system, is not conscious of the study goals, and searches for more information beyond the course contents whenever they desired or required.

III. Research Model and Hypotheses

We have produced the following four groups of hypotheses. The first group relates to the role of stakeholder consensus regarding the importance and value of the four categories of critical success factors. Critical success factors need to constitute corporate e-Learning systems for desirable performances, so are called e-Learning system components in this study. The second group of hypotheses relates to the relationship among these factors, and we supposed the hierarchical relationship in this regard. The third group of hypotheses reflects the theoretically induced influences of

those factors (i.e., e-Learning system components) on the effectiveness of corporate e-Learning systems (i.e., user satisfaction). Finally, the fourth group of hypotheses anticipates the moderating role of the learning subject and the learning style in regards to the effects of those factors.

H 1. The consensus of stakeholders on the importance and value of critical success factors for corporate e-Learning systems positively influences the implementation quality of these factors.

- 1-1. The consensus of stakeholders on the importance and value of contents positively influences the perceived content quality (PCQ).
- 1-2. The consensus of stakeholders on the importance and value of technical features positively influences the perceived technical quality (PTQ).
- 1-3. The consensus of stakeholders on the importance and value of management positively influences the perceived management quality (PMQ).
- 1-4. The consensus of stakeholders on the importance and value of organizational support positively influences the perceived organizational support quality (POQ).

H 2. The perceived qualities of e-Learning system components are in a hierarchical relationship.

The ultimate quality of e-Learning systems depends on content, and content is the major object to be delivered to organizational members. Therefore, we put PCQ at the high point of the hierarchical relationship. PMQ and PTQ are two direct supporting activities that help learners understand and apply the content, which is the main *raison-d'être* for any e-Learning system. POQ sets up the organizational mindset, attitude, and direction regarding e-Learning systems, which then buttresses all relevant activities. Therefore, we present the hierarchical relationship among these factors as follows.

- 2-1. POQ positively influences PTQ.
- 2-2. POQ positively influences PMQ.
- 2-3. PTQ positively influences PCQ.
- 2-4. PMQ positively influences PCQ.

H 3. The perceived qualities of e-Learning system components positively influence the performance of e-Learning systems.

- 3-1. PCQ positively influences the user's satisfaction with e-Learning systems.
- 3-2. PTQ positively influences the user's satisfaction with e-Learning systems.
- 3-3. PMQ positively influences the user's satisfaction with e-Learning systems.
- 3-4. POQ positively influences the user's satisfaction with e-Learning systems.

H 4. The learning subject and learning style moderate

the effects of perceived qualities of e-Learning system components.

- 4-1. The learning subjects moderate the effects of PCQ regarding user's satisfaction.
- 4-2. The learning subjects moderate the effects of PTQ regarding user's satisfaction.
- 4-3. The learning subjects moderate the effects of PMQ regarding user's satisfaction.
- 4-4. The learning subjects moderate the effects of POQ regarding user's satisfaction.
- 4-5. The learning style moderates the effects of PCQ regarding user's satisfaction.
- 4-6. The learning style moderates the effects of PTQ regarding user's satisfaction.
- 4-7. The learning style moderates the effects of PMQ regarding user's satisfaction.
- 4-8. The learning style moderates the effects of POQ regarding user's satisfaction.

IV. Research Methodology

IV.1 Definitions and Operationalization of Variables

Most measurement items were adopted from previous studies and modified to our research context. Two critical issues on the measurement of the consensus of stakeholders were the objects and the degree of consensus. As mentioned already, the objects of consensus are the influential factors for user satisfaction with e-Learning systems. As for the degree of consensus, we adopted the phenomenological approach that puts emphasis on the belief of organizational members regarding the degree of shareness of mental models among themselves and then calculated the Euclid distance among respondent's beliefs about this shareness of mental models.

It was quite challenging to choose the objective measure for the performance of e-Learning systems. User satisfaction and system use are especially popular because direct benefits and costs are associated with many delicate issues, such as time lag, control of exogenous factors, and representation. However, when information systems are in obligatory use due to regulatory or conventional reasons, user satisfaction is more appropriate than system use as the surrogate measure of information system success [2]. Therefore, we adopt user satisfaction because corporate e-Learning systems are compulsory in many organizations.

IV.2 Samples and Data Collection

We first contacted the top three e-Learning service companies in Korea and requested their client list. To avoid sampling bias, we selected companies in various industries and of diverse size. We asked our first contact person of the e-Learning service provider to introduce staffs who had worked for more than two years, and then surveyed the inductees. Then, we contacted the human resource department staff of this client company list, who was in charge of corporate education or e-Learning programs. We

asked the first contact person to introduce more of the corporate education staffs who had been in the same job for more than two years, and then asked these staff persons to cooperate with our research by participating in our interviews, surveys, and introducing the e-Learning system users (learners). Finally, we contacted e-Learning system users who had taken more than two courses in their current organization. The consensus on each CSF was calculated by the Euclidean distance among the perceptions of the user, his/her organization's HR department, and his/her e-Learning service provider regarding the importance of the same e-Learning components. User perceptions on the qualities of these components and user satisfaction were the subsequent indigenous variables of this exogenous variable (i.e., consensus).

We distributed total 500 questionnaires to 3 e-Learning service providers and 18 client companies of these e-Learning service providers. In three weeks, 426 surveys were replied (return rate was 85.2%), and 398 surveys were judged appropriate for further statistical analysis excluding 28 invalid replies. There were 311 end-users (learners), 36 human resource department staffs, and 51 service provider staffs.

V. Data Analysis and Hypothesis Test

V.1 Qualities of Instruments: Reliability and Validity

Reliability of each first-order construct measurement was assessed by Cronbach's alpha. The Cronbach's alpha of 'system quality' in PTQ was 0.58 below the general criterion of 0.6. However, we decided not to exclude this construct because it is one of the major components in PTQ of our research model, and exhibited acceptable reliability scores in other studies.

To investigate whether the questionnaire items measured the constructs as they were supposed to, we tested the construct validity of four, second-order latent variables by examining convergent and discriminant validity. Our convergent validity analysis demonstrated that all the *t*-values of CFA loadings were significant except for system quality and interaction. However, these constructs were not excluded from further analysis because it was important to retain as many original items as possible to preserve the original research design and then compare the results with other studies that used the same scales. The discriminant validity of constructs was assessed by criteria similar to multi-trait/multi-method analysis. To assess discriminant validity, we compared the measures of Average Variance Extracted (AVE) with the correlation values in the corresponding rows and columns. Discriminant validity would be secured if the diagonals exceeded 0.5 and the off-diagonals in the corresponding rows and columns [6]. Discriminant validity was secured for all the second-order constructs.

V.2 Analysis

V.2.1 Goodness-of-Fit Determined by Comparing with

Alternative Competing Models

We constructed two competing models, C1 and C2. When compared to our research model (C3), Model C1 excluded the hierarchical structure among e-Learning system components. Meanwhile, Model C2 admitted the hierarchical relationship among PCQ, PMQ, PTQ and POQ, but assumed that PMQ and PTQ take up only the mediating role between POQ and PCQ without direct influence on user satisfaction with corporate e-Learning systems.

We used RMSEA (Root-Mean Square Error of Approximation) and TLI (Tucker Lewis Index) as goodness-of-fit indexes. RMSEA evaluates the discrepancy between model and data per degree of freedom and simultaneously considers both errors and parsimony of a research model. TLI addresses the enhancement of a research model compared to the null model. RMSEA needed to be less than 0.05 for excellent fit and range between 0.05 and 0.08 for acceptable models [3].

The criterion for TLI used to be 0.9-0.95 [13]. Our model demonstrated 0.066 for RMSEA and 0.94 for TLI, both of which satisfied the acceptable criteria.

However, it is not fair to consider only the goodness-of-fit indexes of research between models without considering complexity (degree of freedom). Therefore, we calculated the trade-off between goodness-of-fit (chi-square value) and parsimony (degree of freedom) among the competing models and concluded that our research model (C3) maintains a better fit than the competing models. C2 was more complicated than C1, thus having less chi-square value ($\Delta \chi^2 = 253.082$) and less degree of freedom ($\Delta \text{Degree of Freedom} = 2$). This improvement was significant, so C2 and C3 were compared next. C3 had less chi-square value than C2 due to model complexity ($\Delta \chi^2 = 10.913$) with the loss of

degree of freedom by 2. This improvement was also significant.

V. 2. 2 Hypothesis Test

Figure 1 presents the result of SEM (Structural Equation Modeling) analysis by AMOS 4.0. Because our model was judged to fit our data, we refer to this model and test our hypotheses.

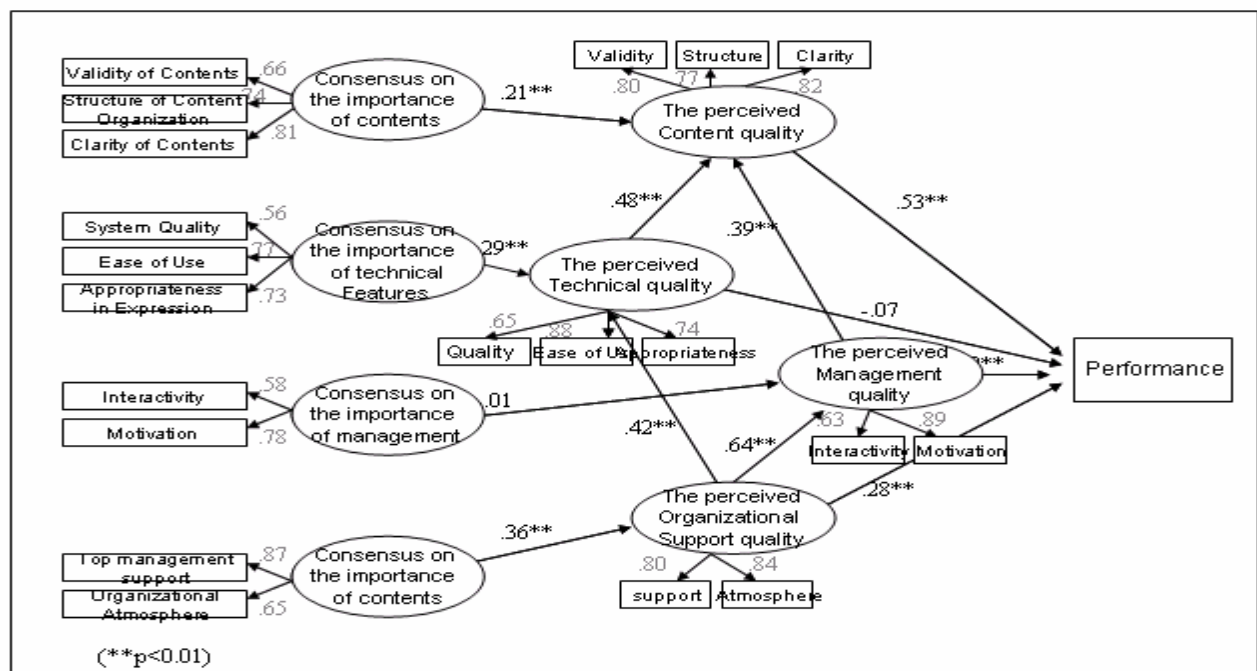
Hypothesis 1 stated that the consensus of stakeholders regarding the importance and value of critical success factors for corporate e-Learning systems positively influences the implementation quality of these factors. The analysis shows that all the path coefficients between stakeholder consensus and quality of critical success factors are significant except for the path to PMQ (Hypothesis 1.3).

Hypothesis 2 stated that the perceived qualities of e-Learning system components are in hierarchical relationships. Our analysis indicates that all the path coefficients are significant ($p < 0.00$) as we assumed.

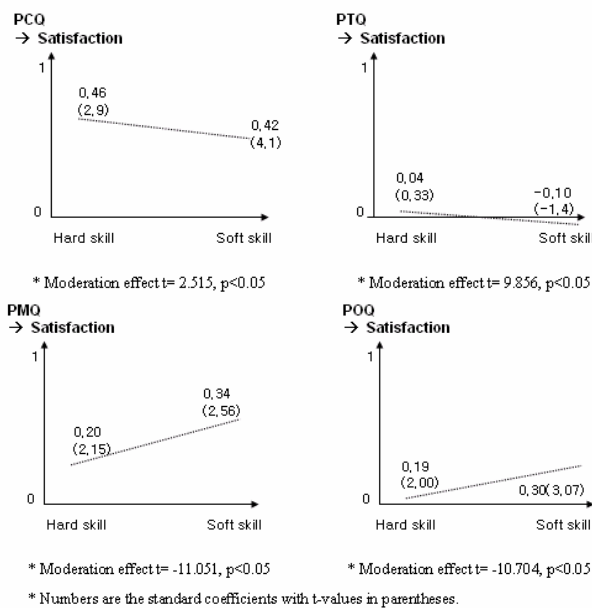
Hypothesis 3 stated that the perceived qualities of e-Learning system components positively influence the performance of e-Learning systems (user satisfaction). Our analysis shows that all the path coefficients between the perceived qualities of e-Learning system components and user satisfaction are significant except for the path from PTQ (Hypothesis 3.2).

Hypotheses 4.1 - 4.4 concern the moderating roles of learning subject between the perceived qualities of e-Learning system components and user satisfaction. Figure 2 demonstrates that the learning subject clearly moderates the effects of the perceived qualities of all the e-Learning system components on user satisfaction.

[Figure 1] Analysis Results

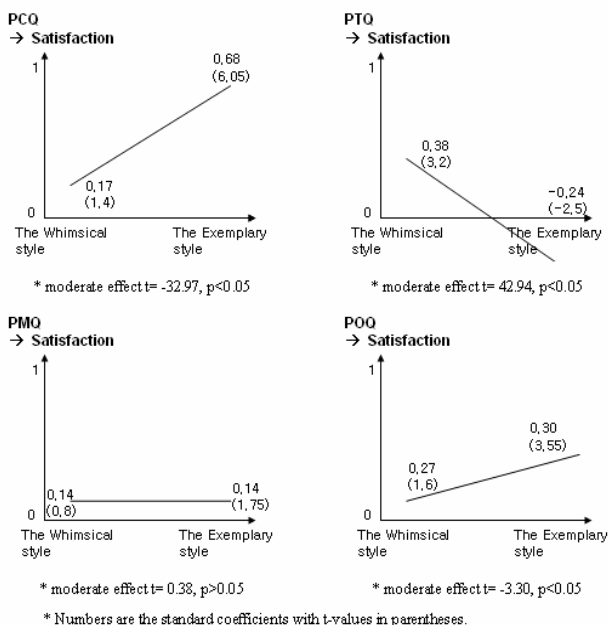


[Figure 2] Moderation Effect of Learning Subjects



Hypotheses 4.5 - 4.8 concern the moderating role of learning style between the perceived qualities of e-Learning system components and user satisfaction. Figure 3 illustrates that learning style significantly moderates the effects of perceived qualities of e-Learning system components on user satisfaction except for PMQ (Hypothesis 4.7).

[Figure 3] Moderation Effect of Learning Style



VI. Discussion and Conclusion

The primary purpose of this study was to recognize who has stakes for corporate e-Learning systems and how their consensus on the importance of e-Learning system

components works on the implementation qualities of these components to eventually influence user satisfaction. In addition, we tested whether the influences of qualities of e-Learning system components change at different contexts, an issue that relates to when we can achieve the maximal value of e-Learning systems. Learning subject and learning style were found to significantly moderate the effects of critical success factors. Our findings can be summarized as follows.

First, stakeholder consensus on the importance of e-Learning system components helps implement most of these components in good quality except for management quality. In other words, stakeholder consensus on the importance of content, technical features, and organizational support for corporate e-Learning systems leads to the implementation of these three components in good quality, respectively. Even though many management services are embedded or cared for by automatic systems, we found that learner perception regarding the quality of e-Learning service provider management is substantially influenced by the personal characteristics (attitude, mission, personality, etc.) of staffs in charge of e-Learning rather than being facilitated by the consensus of related stakeholders. For example, in the case of examination or report submission, learners confessed that they are more thankful for personal calls, emails, or consultation with staff than mechanic or blunt notification from systems because they can talk about their personal problems or negotiate schedules.

Second, in regards to the hierarchical relationship among e-Learning system components, we found that organizational support quality buttresses the quality levels of all the other components. It influenced the qualities of technical features and management, both of which in turn facilitated the realization of content in good quality. Our finding that technical quality leads to content quality implies that learner perception regarding content quality can be improved if the e-Learning system uses more advanced technical features, such as multimedia functions. The influence of management on content quality signifies that the quality of content is not only related to text materials, but also to the interaction with instructors and operators. E-Learning service provider management and technical features are the instruments of the content to be delivered and internalized by learners. The value of such facilities is appreciated much more if user organizations (especially, human resource departments in charge of corporate education) demonstrate strong support for e-Learning programs. Therefore, our study reveals that organizations should establish and demonstrate a strong culture and intent for corporate e-Learning systems more than any other effort.

Third, all the components except for the technical quality, had a positive influence on user satisfaction with e-Learning systems. The reason for the lackluster influence of technical features could be traced to the more recent development of information technologies and a default embedment of such features into most e-Learning systems in Korea. In the past when there was substantial variance in IT features of e-

Learning systems, such features did matter for user satisfaction with e-Learning systems. Such phenomena have recently dissipated because IT features have become quite standardized among e-Learning systems in Korea, so that most e-Learning systems are not differentiated from each other in terms of technical features.

Fourth, we verified that the learning subject and learning style moderated the influences of these e-Learning system components regarding user satisfaction. Particularly, the learning style addressed the more dramatic moderating role. The whimsical style appreciated the qualities of content and organizational support, whereas the exemplary style did not. The exemplary style acknowledged the quality of technical features, while the whimsical style did not.

Our study has the following limitations that need to be overcome by future studies. It seems appropriate to include the role and influence of instructor as another stakeholder as long as the content can be regarded as the core component of e-Learning systems. In our study, the issues of instructor were submerged into content. Future studies can distinguish the issues of instructor from content and analyze the independent influences of instructors on user satisfaction.

MIS studies have been successful in identifying and verifying **what** are the critical success factors for implementation of various types of information systems. Our question was basically related to **how** we can implement these factors and attend to the consensus among stakeholders that facilitate the implementation of those factors. We wish more future studies to elucidate the processes and conditions regarding how we can implement those important factors better for successful information systems.

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The E-Learning Revolution: Opportunities for Higher Education in the 21st Century

Brendan McCarthy
School of Information Systems Victoria University
PO Box 14428
Melbourne City MC Victoria Australia
Phone: +61 3 9919 5079 Fax: +61 3 9919 5024
Email: brendan.mccarthy@vu.edu.au

Abstract: The expansion of education beyond national boundaries has created a new market for the education industry. Many universities have formed partnerships with organisations in other countries in order to expand their programs. Several implementation models have been identified including distance education via E-Learning, study abroad programs, the establishment of a university campus in a foreign country and the travel of faculty lecturers to foreign countries for full or partial curriculum delivery. There has been dramatic growth in the development of electronic interactive learning systems and their application via E-Learning to higher education in the international market. The curriculum associated with Information Systems and in particular the teaching of Enterprise Resource Planning (ERP) systems is particularly suited to the application of E-Learning technologies. Victoria University has extended its offshore programs by offering ERP education in the Asian region and has applied E-learning technologies blending synchronous and asynchronous content to assist this expansion. A number of technologies facilitate teaching: application service provision (ASP), web-CT, computer-based training and virtual classroom technology. This approach provides an innovative and efficient means to deliver higher education internationally in terms of flexibility in subject delivery and increased learning outcomes.

Keywords: E-learning, Innovations in Teaching, Synchronous E-learning, Asynchronous E-learning, E-Learning Technology.

I. Introduction

The expansion of global education has created a new market for the education industry. Aoki (2004) has identified four trading service modes defined within the framework of the General Agreement on Trade in Services (GATS) and applied these to the education market:

Mode 1 – Cross-over supply: E-Learning in which the education provider and student do not relocate.

Mode 2 – Consumption Abroad: Study programs where the student travels to a foreign country.

Mode 3 – Commercial Presence: The establishment of

programs in another country.

Mode 4 – Presence of Natural Persons: Educators travel to another country to present program.

Aoki (2004) asserts that E-Learning allows educational services to cross over national boundaries. Demand for education is particularly strong in developing countries where education is seen as an important ingredient to economic prosperity. Many universities have introduced distance learning programs and are trialling E-Learning tools to support their expansion into the international education market. Several have formed partnerships with other institutions to enter the international education market taking advantages of new developments in E-Learning technologies. Aoki (2004) describes four well-known international consortia: U21global, Global University Alliance (GUA), World Alliance in Distance Education (WADE), and Cardean University.

Many studies have been carried out on the effects of E-Learning on a university's education strategy. Chan and Welebir (2003) describe the effects of the Internet and online distance education on a university's overall strategy. They present a strategic agenda that traditional universities can follow to develop E-Learning programs including the suggestion of forming a strategic alliance to enter the e-education market and expand globally. Gibson (2001) suggests that the virtual classroom will eventually replace the traditional classroom. His study explores methods to enhance the distance learning experience and create a competitive advantage.

II. ERP Curriculum

Curriculum associated with the teaching of Enterprise Resource Planning (ERP) systems is more suited to the use of E-Learning tools than many other areas especially where the curriculum is expanded beyond the traditional boundaries of universities (Hawking and McCarthy, 2001). ERP systems are modular application software that helps businesses increase the productivity of such mission-critical components as human resources, finance, parts purchasing, inventory control, supply chain and customer relationship management. ERP systems are enterprise-wide and claim to incorporate best business practice that replaces legacy systems and current business processes. The leading ERP vendor is SAP. SAP maintains about 35% of the worldwide ERP market (Gilbert, 2000) and its ERP product is called

SAP R/3.

An increasing number of universities are investigating strategic alliances with ERP system vendors to provide the support for incorporating ERP knowledge into their curriculum (Hawking, 1998). The ERP vendor benefits from these alliances by increasing the supply of skilled graduates that can support their product thereby enhancing its marketability. Chan and Welebir (2003) highlight the competitive advantages universities can gain by forming alliances, particularly their benefit in leveraging into the global e-education market.

The SAP University Alliance Program in Australia is an example of a strategic alliance between a number of universities and an ERP vendor. As part of the alliance, SAP provides approximately \$2.5 million worth of its product and technical and professional support for the integration of SAP R/3 into the curriculum. However it is still the responsibility of individual academics to develop the necessary curriculum and the university to provide the necessary infrastructure to support the system.

III. International Education

The Faculty of Business and Law on behalf of Victoria University joined the University Alliance Program in 1998 and has developed a Graduate Certificate, Graduate Diploma and Master of Business in Enterprise Resource Planning Systems as well as incorporating SAP R/3 into several undergraduate subjects. Currently we have 15 staff teaching more than 20 subjects at both the undergraduate and postgraduate levels to approximately 700 students.

Many higher education institutions are making plans to globalise their courses. Victoria University is no exception and offers a broad range of academic programs throughout the Asian region. The international programs involve over 3500 students from Malaysia, Singapore, Thailand, People's Republic of China and Bangladesh. Many of these universities have indicated that they wish to include ERP related subjects in their courses. While there have been indications that the high growth rates in the ERP market of recent years have somewhat dwindled, good growth has been maintained in many Asian markets with the expectation of continued growth in the foreseeable future (Pinaroc, 2000). SAP has established a University Alliance Program in many Asian countries to assist with provision of appropriately educated consultants to support this increased market. However even though these alliances have been established many of the universities have had difficulties in developing curriculum due to lack of skilled staff and available resources. Increasingly Asian universities are forming partnerships with foreign universities in an endeavour to broaden their curriculum offerings and add value to their students. Clearly there are advantages to be gained by both parties in setting up a partnership to teach different aspects of ERP systems. The provider is able to derive income to recoup some of the cost of developing curricula and maintaining systems while the receiver obtains

the benefits of their students acquiring ERP education without the need to invest in hardware, staff training and curriculum development.

In 2002 Victoria University commenced the Master of Business in ERP Systems at Sumbershire Business School, Singapore. In February 2005 the ERP masters program commenced at the Beijing Jiaotong University, P.R. of China. We are currently negotiating the introduction of ERP studies with institutions in Malaysia, Thailand and Tanzania.

IV. The Application of E-Learning Technology

Many E-Learning models have been developed and trials conducted in recent years. Neubauer and Lobel (Neubauer and Lobel, 2003) describe a highly structured synchronous model for teaching and doing research on medium to large sized groups over the Internet. Arnone (2002) reports on the technical standards being developed to allow colleges in the US to customise distance-learning programs by blending online-learning software from several vendors. Ehrmann and Collins (Ehrmann and Collins, 2001) describe examples of virtual classrooms that use the Internet to create new kinds of collaboration and learning. Tansley and Bryson (2000) evaluate the implications of replacing traditional modes of small group teaching with "virtual seminars".

Victoria University uses E-Learning technologies to facilitate the teaching of ERP systems in our offshore programs. The E-Learning technologies blend synchronous and asynchronous content. Asynchronous E-Learning does not involve the presence of the teacher. Typically the learning content is located on a web server that students can access using the Internet. The content can be interactive but the presence of the teacher is not required. Typically asynchronous E-Learning is implemented by Web-based training (WBT) and may include online forums, threaded discussions and download materials. Synchronous E-Learning requires the learner and teacher to be present in the event at the same time. It is a real-time, instructor-led online learning event in which all participants are available at the same time and can communicate directly with each other.

To support offshore teaching a model for ERP E-Learning has been developed and has been applied in Singapore since 2002 and China in 2005. It is also used in a limited way in an offshore program in Hong Kong. The model blends synchronous and asynchronous content and integrates four major technologies which provide a comprehensive medium for online learning.

The technologies are:

Application Service Provision

Application Service Provision (ASP) is responsible for providing the necessary technological infrastructure and support to host a particular software product. This enables the clients of the ASP to remotely access the software via the Internet. One of the barriers to ERP education mentioned earlier was gaining access to the ERP system and providing the necessary infrastructure. The ASP model provides a

solution to overcoming this barrier.

Victoria University has configured one of its SAP servers to support the role of an ASP to its partnering universities in Asia. Students from these universities can access the SAP software at Victoria University via the Internet once they have installed the SAPgui software on their local PC's. Students can access the SAP software from anywhere in the world as if they were sitting in front of a PC at Victoria University.

The control and administration of the ERP system is still the responsibility of Victoria University and allows our Asian partners to access SAP R/3 without the need to purchase an expensive computer server and employ the necessary support staff. Through the use of clients in the SAP R/3 the system can be individually configured to suit the learning objectives of each offshore institution.

Web-CT

Web-CT is a web based tool which acts a repository of learning materials to assist students with their ERP education. Web-CT has tools for storing and delivering course materials including text, graphics, audio and video. Material can be released according to various criteria, such as date and student name.

Web-CT also has tools for organising and enhancing course material, communication tools so that chat, "internal" mail, discussion groups and whiteboards can be made available for use by students and instructors and tools for monitoring student progress and providing feedback.

In terms of ERP delivery the Web-CT site allows students to view and download subject outlines, assignments, past examination material and lectures in various formats. Students can submit assignments via the site and then view their results once the assignments have been marked. Chat facilities can be enabled to allow students to discuss set tutorial questions and discuss issues they have encountered. This interaction may occur between students within their tutorial, university, other Asian universities, or Victoria University.

Web-CT is used as the foundation to deliver the asynchronous E-Learning content in the ERP offshore program.

SAPTutor

This tool is used for developing interactive tutorials in a simulated SAP environment. It enables the lecturer to record an action or transaction within the SAP environment and capture the screens involved to form the basis of a tutorial. After recording the tutorial, the SAPtutor Editor is used to edit the structure of the tutorial, define alternative paths (branching), edit instructional texts and create additional supplementary descriptive texts. This facility allows educational concepts to be inserted into tutorials using tools such as PowerPoint. The computer-based tutorials enable students to combine ERP theoretical concepts with the appropriate SAP screens and actions. Students can replay the tutorial as many times as necessary to understand the

concepts.

The SAPtutor tool enables staff in the Asian location to have access to a repository of ERP educational materials overcoming the lack of resources barrier identified earlier. The Virtual Classroom technology is used for plenary sessions to reinforce the concepts covered and answer any questions coming out of the SAPtutor tutorials.

This tool has the added benefit of capturing and storing a lecturer's knowledge that can then be reused by others at a later stage either in a different subject or to assist if the lecturer is no longer available.

Virtual Classroom

There is a growing trend amongst academics to use the Internet to increase access to educational materials in a variety of ways to support the learning process (Pather and Erwin, 2000). The ASP enables access to the ERP system while the Virtual Classroom technology provides access to the curriculum.

The virtual classroom tool enables synchronous E-Learning whereby the learner and teacher are present in the event at the same time. It is a real-time, instructor-led online learning event in which all participants are available at the same time and can communicate directly with each other. This virtual classroom capability is facilitated by the Centra Corporation virtual classroom software, Central Symposium, which provides the capability to deliver live, instructor-led classes direct to student desktops using fully integrated voice-over-IP technology. This is used to present theoretic concepts related to ERP Systems and practical demonstrations related to SAP software. Lesson delivery includes integrated full-duplex audio, interactive whiteboards, application sharing, breakout rooms and online surveys and evaluations. The technology allows lessons to be recorded for editing and playback. Centra Symposium is very powerful as it integrates many interactive tools that can be used in the live delivery. Of particular note is the "Application Sharing" tool that allows an application stored on the presenter's PC to be viewed on the students PCs. The presenter can demonstrate features of the application to students in the session and also give control of the application to individual students and allow them to utilise and manipulate the application. This is a very powerful feature and quite unique.

If a student has a query, they can "summon" the lecturer via the Virtual Classroom and the lecturer can then appropriately respond to the query. This two-way communication facilitates the interaction between the lecturer and student thus enhancing the learning process. This has been lacking in many of the online solutions up-to-date.

V. Conclusion

The application of E-Learning technology can provide opportunities for universities to expand their education services beyond national borders. Many universities have

formed partnerships with other institutions to expand their programs offshore; many of these are using E-Learning technology. The four E-Learning technologies used to deliver ERP education in the Asian region provide an efficient means to deliver higher education internationally in terms of flexibility in subject delivery and increased learning outcomes. The application of E-Learning technology will become increasingly relevant in the light of the growing demand for education services by developing countries.

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Knowledge Modeling for Developing Program Planning Agents

Fuhua Lin, Qin Li, Dunwei Wen
School of Computing and Information Systems, Athabasca University
Athabasca, AB, Canada, T9S 3A3
Tel: 1-780-4212548, Fax: 1-780-6756186
Email: [\[oscarl | qinl | dunweiw\]@athabascau.ca](mailto:[oscarl | qinl | dunweiw]@athabascau.ca)

Abstract: This paper describes a method of domain knowledge modeling for program planning and scheduling in intelligent e-Learning advising systems, focusing on the modeling and representation of precedence relations among course learning objects encoded in model curricular and the representation of domain experts' knowledge using Petri nets formalism and a XML-based markup language. We developed a Web-based program model editor.

Keywords: E-Learning & innovations in teaching, knowledge modeling and representation, program planning, Petri nets.

I. Introduction

Curriculum planning for student advising is an interactive decision-making process, which assist learners in the development of meaningful learning plans which are compatible with their career/life goals maximize educational potential through communication and information exchanges with an educator. An intelligent e-learning planning agent is a knowledge-based system able to assist e-learners to generate a personalized curriculum best suitable for them. The abilities of such a system hinge on possessing knowledge about the domain and program structure, learners, and pedagogy.

One of the important tasks in developing intelligent program planning systems is to model and represent the program model in the context so that the scheduling agents can use it to generate learning plans flexibly and adaptively. Due to the complex pre-requisite relationships among the course learning objects, this task is not trivial. This paper presents a Petri nets based model of program structure knowledge modeling and XML-based representation for dynamic program planning. We develop a knowledge editor for constructing and maintaining curriculum models.

To demonstrate the feasibility of the model, we developed an intelligent advisor able to generate personalized curriculum and generating a schedule for the courses selection according to students' temporal constraints, and course availability.

This paper mainly describes the method of domain knowledge modeling and representation for program planning and scheduling in e-Learning, focusing on the representation of precedence relations among course

learning objects encoded in model curricular and the representation of domain experts' knowledge.

We proposed an extended Petri nets model to represent the logical relationships among courses in a curriculum. We developed a Web-based knowledge editor providing straightforward modification to accommodate addition or deletion of courses, prerequisites, co-requisites, and rules.

To demonstrate the feasibility of the model and the editor, we show a real-world example of Petri nets represented course-flow for MSc IS program of Athabasca University of Canada.

II. Literature Review

The literature records several efforts to employ computers to reduce the tedium, and improve the consistency, in student advising [1-7]. These systems exploit AI, expert systems or knowledge-based systems to provide some of the functions of a faculty advisor to students. Several of them provide students with a prioritized list of suggested courses and check prerequisites and sequencing. Most of them were designed to run on mainframes environments or standalone PCs. Gunadhi, et al., (1995) presented a framework for an intelligent advisory system for college students that combine object-oriented and knowledge-based paradigms [3]. They did not address how to acquire and incorporate "real-life" expertise and how to interface to other systems in the university such as online registration system, academic and student databases.

Flow diagrams, narrative descriptions, and time-line analysis are useful for a variety of modeling problems. Those tools however make it difficult or impossible to expose critical time-dependencies, task concurrencies, and event-driven behavior. Petri nets are a useful and powerful modeling tool and overcome the aforementioned shortcomings [8].

In curriculum modeling, an important task is representing the complex logical relationships among the prerequisites. Both state machines and graphs do not have capability to model curricular. State machines with the property that each transition has exactly one incoming and one outgoing arc or flow relation. They are a subclass of P/T nets [8]. State machines allow us to model choice or decision. Because each place may have multiple output transitions, they do not allow modeling of synchronization or concurrent activities, which are common in a curriculum. Concurrent activities require that several transitions be enabled concurrently [9]. In a marked graph, each place has

only one incoming and one outgoing flow relation; thus, marked graphs do not allow modeling of choice while choices are important in course-choosing.

Knowledge modeling using Petri nets and its extensions in AI applications has received much attention. Net related models have been proposed for validating knowledge bases [10]; diagnostic knowledge representation and reasoning [11], determining requirements [12], and representing knowledge in discrete event systems [13].

K. Lee and M. Y. Jung (1994) presented a method for flexible operation planning using the Petri net approach [14]. A Petri net is used as a unified framework for both operation planning and plan representation.

III. Curriculum Petri Nets

Before describing the proposed Petri nets model, let us review the ordinary Place-Transition Nets.

III.1 Place-Transition Nets (P/T nets)

Place-Transition nets (P/T nets) are the basic type of Petri nets from which all other types are derived. They consist of four elements [8]:

(1) **Places:** places model conditions or objects such as program variables. They are represented by circles.

(2) **Tokens:** tokens are represented by black dots. These are contained within places and represent the specific value of the condition or object which that place represents. The initial arrangement of tokens on places is known as the *initial marking* of the Petri net.

(3) **Transitions:** transitions are represented by hollow rectangles and model activities which change the values of conditions and objects.

(4) **Arcs:** arcs are represented by lines connecting places and transitions. These indicate which objects are changed by which activities. As Place-Transition nets are bipartite, arcs may only connect places to transitions or transitions to places, but not places to places or transitions to transitions. An arc may have a *weight*, which specifies how many tokens are created or destroyed when a transition to which it is attached is fired.

A P/T net can be defined formally using functional notation:

Definition 3.1: (P/T nets)

A Place-Transition net is a 5-tuple

$$PN = (P, T, I_-, I_+, M_0)$$

where

$P = \{p_1, \dots, p_n\} (n < \infty)$ is a finite and non-empty set of places;

$T = \{t_1, \dots, t_m\} (m > 0)$ is a finite and non-empty set of transitions, $P \cap T = \emptyset$;

$F \subseteq (P \times T) \cup (T \times P)$ is a set of directed arcs, called flow relations;

$I_-, I_+ : P \times T \rightarrow \mathbb{N}_0$ are the backward and forward

incidence functions respectively; If $I_-(p, t) > 0$, an arc leads from place p to transition t , whilst if $I_+(p, t) > 0$ then an arc leads from transition t to place p ; $M_0 : P \rightarrow \mathbb{N}_0$ is the initial marking.

The dynamic behavior of a P/T net is determined by rules concerning the enabling and firing of transitions. When the arcs connecting a transition to its input places have a weight of one, the transition is enabled if all of its input places are marked with at least one token. Only an enabled transition may fire. When it does, one token on each of its input places is removed and one token is created on each of its output places. It is possible, however, for an arc to have a weight greater than one. In this case, if the arc is an input arc then the transition is only enabled if the number of tokens on the place to which it is connected is equal to or greater than its weight. When then transition is fired, the number of tokens removed on the place is equal to the arc's weight. If it is an output arc, firing the transition creates the number of tokens on the output place equivalent to the arc's weight. The numerical values of each of the I_- and I_+ functions correspond to the weights of the arcs connecting places and transitions. By convention arc weights of 1 are not shown explicitly.

The rules for the enabling and firing of transitions can be formalized thus:

Definition 3.2: (Firing rules of P/T nets)

If $PN = (P, T, I_-, I_+, M_0)$ is a P/T net. A marking of a P/T net is a function $M : P \rightarrow \mathbb{N}_0$, where $M(p)$ is the number of tokens on place p , $\mathbb{N}_0 = \{0, 1, \dots\}$;

A set $P_1 \subseteq P$ is marked at marking M , only and if only (iff) $\exists p \in P_1 : M(p) > 0$; otherwise P_1 is unmarked or empty at M ; A transition $t \in T$ is enabled at M , denoted by $M[t >]$, iff $M(p) \geq I_-(p, t), \forall p \in P$; A transition $t \in T$, enabled at marking M , may fire yielding a new marking M' where

$$M'(p) = M(p) - I_-(p, t) + I_+(p, t), \forall p \in P,$$

denoted by $M[t > M']$. In this case M' is directly reachable from M and we write $M \rightarrow M'$. Let \rightarrow^* be the reflexive and transitive closure of \rightarrow . A marking M' is reachable from M , iff $M \rightarrow^* M'$; A firing sequence of PN is a finite sequence of transitions $\sigma = t_1 \dots t_n$ $n \geq 0$ such that there are markings M_1, \dots, M_{n+1} satisfying $M_i[t_i > M_{i+1}], \forall i = 1, \dots, n$. A shorthand notation for this case is $M_1[\sigma >]$ and $M_1[\sigma > M_{n+1}]$, respectively. The empty firing sequence denoted by ε and $M[\varepsilon > M]$ always holds.

The firing of a transition when the P/T net has one marking creates a new marking. The set of all markings

which are reachable from M_0 is known as the *reachability set* of the net and the connections between the markings in this set are represented by the reachability graph.

We extended P/T nets to model concurrent course taking activities, complex course dependency relations (e.g. prerequisites, co-requisites), preferences (priorities), and exclusion.

III.2 Curriculum P/T Nets

Course-taking process for an e-learner can be viewed as a process of changing the states of knowledge of the e-learner. To take a course, a learner's state of knowledge must meet the prerequisite requirement. After completing a course, the learner's state of knowledge is changed. The process of taking courses is then represented by a nondeterministic firing and passing the markers. The state of knowledge of a learner is thus denoted by the markup of the Petri net.

Definition 3.3 (Curriculum P/T nets):

A Curriculum P/T net

$$PN = (P, T, I_-, I_+, M_0)$$

is an extended P/T net,

$$PN = (P, T, I_-, I_+, M_0)$$

defined in **Definition 3.1** and **Definition 3.2** with the following extensions.

- (1) **Transitions T :** Learning a course is mapped as a transition in a curriculum Petri Net, called course transition.
- (2) **Places P :** We use places of P/T nets to indicate three types of the states in a program-perusing process.
 - (a) **Done Places:** There is only one output place for each course transition. That output place is named as Done Place. For example, the output place for course transition "Java Programming" is done place p_2 in Figure 1.
 - (b) **Ready Places:** We use an input place to represent the readiness of a prerequisite course of a course transition. There may be zero, one or many input places for a course transition. If a course has no prerequisite course, we still add an input place for that transition. That input places are names as Ready Places. If a done place of a course transition may be a ready place of another course transition. For example, course "Object-Oriented Programming (COMP501)" has no prerequisite courses in the program; its input place is Ready place p_1 ; p_2 is also a Ready place of course transition "Distributed Systems (COMP689)" as shown in Figure 1.

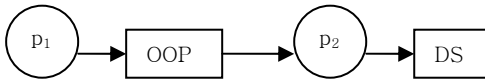


Figure 1: Example for Ready Places, Done places, and course transition.

- (c) **Choice places:** we use a special place as a common input place of a set of course transitions to represent a situation of multiple choices in a curriculum. For example,

an MSc IS student at Athabasca University can take only either "IS integration essay" or "IS Integration Project", once the student completes the IS Foundation Courses and Core Courses. So, we set a Choice place p_3 to represent the case of exclusion (see Figure 2).

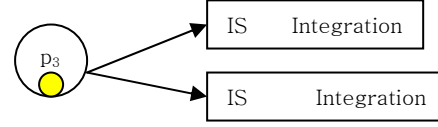


Figure 2: Example for choice places

- (3) **Markings M :** The markings in an input place p of a course transition t represent the readiness of the prerequisite course t_0 in which the place p is its output place. If there is a token in an output place of a course transition, then the student already finishes the course.

- (4) **Incidence functions I_+ , I_- :** Considering one course can be the prerequisites of many courses, and it is hard to predict how many succeed courses of course t will be selected by a learner pursuing a program. Also, a learner may re-take a course to get a better mark. To keep the status that this course has been completed during the process of the program completion, we use a special incidence functions for all places in curriculum P/T nets:

- Once course t is done, one token will be created in its Done place p , i.e. $I_+(p, t) = 1$;
- No token in a Ready place p will be destroyed when its course transition t is fired, i.e. $I_-(p, t) = 0$;
- For a Choice place, one token will be removed from it when its course transition is fired, i.e. $I_-(p, t) = 1$.

- (5) **Firing rules:** We extend the ordinary P/T nets by assigning a new firing rule:

A transition t in T is enabled at M , denoted by $M[t >, \text{iff}]$ the condition predicate $pre(t)$ holds: predicate $pre(t)$ is formed by using the Boolean operators (AND, OR, NOT) over the place set $\{M(p): I_-(p, t) > 0, p \in P\}$.

The predicate only contains Boolean operators OR, AND, and NOT, and does not contain XOR operator, because the case of exclusion is represented by *Choice* places.

We classify the all possible pre-requisites into four categories:

Basic type:

(1) AND: $C_1 \wedge C_2 \wedge \dots \wedge C_n$;

(2) OR: $C_1 \vee C_2 \vee \dots \vee C_m$;

(3) n OUT of m : $\{n, C_1 \vee C_2 \vee \dots \vee C_m\}$;

More generally, complex type:

(4) $G_1 \wedge G_2 \wedge \dots \wedge G_l$,

$G_i (i = 1, 2, \dots, m)$ is a condition expression of ' n OUT OF

m' type.

For example, one of the most commonly-used prerequisite conditions is “to take course C , learners must take X course out of Y courses, some are mandatory”. The condition represents that a student must take X prerequisite courses of course C , from Y courses to enable the course transition P . some of them are mandatory, Then the $pre(t)$ can be described as follows:

(1) $\forall p \in P$, if the course transition which uses p as a *Done* place is a necessary course (the inscription of Arc connecting the input place and the transition is *MANDATORY*) then $M(p) > 0$; and

(2) $(\sum_p M(p) \times I_-(p, t)) \geq X$.

IV. Petri Net Markup Language

Petri Net Markup Language (PNML) is an XML based standard format for the interchange of Petri nets. The main elements in the PNML file for a curriculum are Transition, Place, and Arc. These three elements represent the three kinds of basic elements in a Curriculum Petri Net. Each of those elements has its sub-elements. To represent curriculum Petri nets using PNML, we do not have any element for the firing rules in the PNML, because we do not use a standard firing rule to fire the course Petri nets automatically. Instead, we set up a special business rule that implemented to fire the transitions of curriculum Petri nets.

In order to illustrate the PNML format, Figure 3 shows a very simple sub-net of a curriculum Petri net shown in Figure 1 and its corresponding PNML description. In between the `<place id="p1">` and `</place>` tags, everything about that place is described. The value of its initial marking is contained between the tags of that name. The transitions are similarly described, whilst the arcs record their starts and ends as the nodes which they connect.

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<pnml>
  <net id="n1" type="BlackTokenNet">
    <name> An Example of Curriculum Petri Net </name>
    <place id="READYCOMP501">
      <marking> <value>1</value> </marking>
      <name>
        <value>READYCOMP501</value>
      </name>
    </place>
    <initialMarking><value>1</value></initialMarking>
    ...
    <arc id="a1" source="READYCOMP501"
      target="COMP501">
      <inscription>
        <requirement>MANDATORY</requirement>
```

```
        <direction>input</direction>
        <value>0</value>
      </inscription>
    </arc>
    ...
    <transition id="COMP501">
      <name>
        <value>1</value>
      </name>
    </transition>
  </net>
</pnml>
```

Figure 3: An example of PNML-represented curriculum Petri nets.

To represent the complex relation of prerequisite courses in the `<value>` in transition node of the PNML, we use a special expression

```
<value>
m1, course1, course 2, ..., course n1;
m2, course1, course 2, ..., course n2;
...
ml, course 1, course 2, ..., course nl
</value>
```

($l > 0$, $m_i < n_i$, $i = 1, 2, \dots, l$). Here symbol ';' separates course groups. l is the number of the groups. m_i is the number of the required courses and n_i is the number of the courses to be selected.

For example, the value element in the transition node of the PNML for COMP696 is:

```
<value>
4,COMP501, COMP503, COMP504, COMP601;;
5,COMP603,COMP604,COMP605,COMP607,
COMP610, COMP695,COMP617;;
</value>
```

Here symbol ';' separates course groups. So, COMP696 has two course groups as its prerequisite courses. In the first course group, there are four courses, and four courses are required to be taken in that course group. It actually means every course is MANDATORY. In the second course group, there are seven courses, and five courses are required to be taken in that course group.

In this value string, we can't tell which course is MANDATORY or OPTIONAL. We can get that information from the inscription of Arc connecting the input place and the transition. In this example, among all these prerequisite courses in the second course group, only COMP695 is MANDATORY.

V. Web-Based Program Knowledge Editor

We developed a Petri nets based knowledge editor by using an extended PNK [15] which is a Java-based Petri Net

Kernel (PNK) providing an infrastructure for bringing ideas for analyzing, for simulating, or for verifying Petri Nets into action. Petri nets can be loaded and saved in PNML [16], a language for the description of Petri nets based on XML. This Web-based knowledge editor provides administrators with a convenient tool for the construction and maintenance of program models by adding, updating, or deleting courses, prerequisites, co-requisites, and rules. Figure 4 and 5 show the four steps to adding a course into course dependency database using the developed Web-based program knowledge editor.

The figure shows two screenshots of a web application titled "Add a Course into Course Dependency Database".

Step 1 of 4: A form with the text "Please input the course name" followed by a text input field containing "COMP617".

Step 2 of 4: A form with the text "Please input a prerequisite course name" followed by a text input field containing "COMP695" and an "Add to list" button. Below this is a section titled "Prerequisite courses list:" containing a scrollable list of course IDs: COMP602, COMP603, COMP604, COMP605, COMP607, COMP610, and COMP695. There is a "Delete from list" button at the bottom right of the list.

Figure 4: Step 1 and step 2 of adding a course into course dependency database using the Web-based program knowledge editor.

The figure shows two screenshots of the web application.

Step 3 of 4: A form with the text "If the number of the prerequisite courses shown above is more than one, Please indicate the relationship between the prerequisite courses". It contains four radio button options: (1) AND, (2) OR, (3) X OUT OF Y, and (4) X OUT OF Y, SOME ARE MANDATORY. Option (4) is selected.

Step 4 of 4: A form with the text "Please indicate among all the prerequisite courses, Students have to take at least how many courses : 5" (the number 5 is in a text input field). Below this is the text "If some of prerequisite courses are mandatory, please choose them". It contains two scrollable lists: "Prerequisite courses list:" (with the same list of course IDs as in Figure 4) and "Mandatory courses list:" (which currently contains "COMP695"). There are "Add to Mandatory" and "Delete from Mandatory" buttons at the bottom.

Figure 5: Step 3 and step 4 of adding a course into course dependency using Web-based program knowledge editor.

We applied the ontology-driven software development methodology for Web services and agents for the Semantic Web to develop a program planning agent --- e-Advisor [17]. Maximizing openness and choice can lead to learners making poor choices, thus flexible systems need to be accompanied by strong advice, monitoring and support systems [18]. Our continuing challenge is to maximize the quality and, availability of this support while continually reducing its cost. Given the wide number of courses choices or paths through the curriculum, it is important that each student be assigned an academic advisor who is a

faculty member of the School of Computing and Information Systems. To be effective, advisors and faculty need to understand each individual student's educational and career objectives, their time and financial constraints, and their progress through the program. These can then be matched against degree requirements, course start dates, course availability, and prerequisites in order to generate a personalized course path. The provision of effective program advice for the average of 30 graduate students per faculty member is a time consuming task. In order to meet the students' needs and to reduce the workload of the advisors, we are developing an intelligent agent able to provide the students with an automated MSc IS Graduate program scheduling service (GPSS). On behalf of the students' advisors, the agent will assist them in generating *up-to-date*, *personalized*, and *optimal* study plans by constantly monitoring and utilizing related information resources.

The plan generation is executed by the Petri net program in the MSc IS ontology as a constraint-solving process. To communicate with Web services, the scheduling agent has to wrap its messages as SOAP messages. We are using Axis (<http://ws.apache.org/axis/>) and Java to build and deploy all Web services.

VI. Conclusions

The curriculum P/T net model proposed in this paper is able to represent accurately and dynamically the course-taking procedure for a given curriculum, provide a graphic tool for knowledge representation of the type of precedence relations constraints, provide a powerful simulation tool for program planning, give all possible solutions/study plans by simulation tracing or reachability analysis.

We are working on the verification (model-checking) module of curriculum Petri nets based program models and Web Services for Accessing PNML-represented program models. We are also exploring how to apply this approach to modeling concept ontology for developing intelligent e-learning systems.

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Diffusion of Innovation: An Investigation of e-Procurement Assimilation in the Australian Public Sector

Kishor Vaidya (PhD Candidate)

kishor@turing.une.edu.au

School of Mathematics, Statistics and Computer Science, University of New England,
Armidale, NSW 2351, Australia

Abstract: As part of a larger research project whose objective was to determine the antecedent condition for e-Procurement assimilation, this paper assesses the diffusion of e-Procurement in the Australian public sector. With the help of an extensive literature review and pilot study, e-Procurement diffusion attributes were identified, a research model was developed and hypotheses were formulated. Based on the Diffusion of Innovation theory, it is hypothesized that perceived benefits and compatibility impact positively whereas the perceived complexities negatively impact the transactional and strategic assimilation of e-Procurement. A nationwide web-based survey of Procurement/e-Procurement professionals in the Australian public sector is in the final stage of completion at the time of writing of this paper and analysis of the complete set of data will be presented in the camera-ready version of the paper.

Keywords: Electronic Procurement, Diffusion, Assimilation, Procurement

I. Introduction

Procurement innovation such as Electronic procurement (e-Procurement) is breaking new ground within the public sector of the advanced as well emerging economies by providing the governments with a wealth of supply chain information via the Internet. E-procurement has been on the political agenda in a number of countries [15]. As such, the past few years have seen the greater popularity of e-Procurement technologies in that the governments in the advanced economies including Australia, the USA, and the UK as well as the governments in the emerging economies including China, India, the Philippines, Mexico, Brazil, and Korea are implementing e-Procurement initiatives as part of their Electronic Government (e-Government) agenda. However, just implementing an e-Procurement system is no guarantee to improved procurement performance. It is important that the contextual interrelations between the organisation and management, practices and processes and systems and technology be examined, understood and documented before deciding that e-Procurement might improve procurement performance [29]. The authors advocate such hybrid model for studying e-Procurement implementation processes, particularly for understanding the

implementation events that occur and the antecedent conditions that promote or inhibit implementation outcomes.

The potential benefits of an e-Procurement system commonly include more effective inventory control, reduced purchasing agent overhead, reduced lead times, and competitive pricing [32]. Despite the potential benefits, organizations differ in the speed with which they assimilate e-Procurement and in the level of actual benefits achieved among the organizations that have implemented. The popularity of e-Procurement, at the same time, has raised several research questions that deserve answering in relation to its assimilation. What are the antecedent conditions that could lead towards diffusion of e-Procurement? Which theory can best explain the prevalence of such condition? What would be the impact of such conditions on transactional and strategic assimilation of e-Procurement? This paper attempts to address these questions. As such, following the definition and scope of e-Procurement, this paper conceptualizes the dependent variable for this study – the intensity of organizational assimilation of e-Procurement in the third section. The theoretical support for this study has been provided by the Diffusion of Innovation theory, which has been discussed in the fourth section. The fifth section presents the research model and hypotheses and the sixth section discusses the research methodology adopted. Following the results of the data analysis in the seventh section, this paper concludes with the discussion of limitations of this research and its implications to academics and practitioner in the eighth section.

II. E-Procurement Assimilation: A Literature Review and Development of Hypotheses

This paper regards e-Procurement as the innovation in procurement, as part of e-Government, defined as internet-based applications between two or more companies. An important innovation attribute is the degree to which an innovation creates changes in the structure and functioning of the organization, which requires aggressive technological policy [30]. Damanpour [5] terms this sort of innovation as the “radical” innovation and argues that radical innovations produce fundamental changes in the activities of an organization while routine innovations result in little departure from existing practices. It is important to note that e-procurement is not only the example of radical innovation but also the process innovation. This is emphasized by Sheng, [26], in [5]) that e-Procurement should not only be considered as the re-engineering of old

manual processes but as the re-engineering of the process itself.

The extant literature on technological innovations and electronic commerce has contributed significantly to our understanding of e-Procurement assimilation. However, this literature has limited applicability for investigating the extent of organizational assimilation in the public sector. This is because the technological and transactional characteristics of the Internet differ significantly from other technologies (e.g. EDI) examined in the prior literature. E-procurement assimilation within the same public sector agency may differ between the two phases of assimilation, i.e., e-Procurement use may be high in transactional phase but not in strategic phase, or vice-versa. Furthermore, e-Procurement use may vary extensively across organizations. A comprehensive investigation of this widespread variation necessitates that we conceptualize and examine the organizational assimilation of e-Procurement in both transactional and strategic phases.

Given the definition and scope of e-Procurement in the above section, the intensity of e-Procurement assimilation can be further defined as the degree of adoption, implementation and utilization of e-Procurement technologies across the transactional and strategic procurement process. Although the literature gives account of the various steps or stages in the procurement process, this paper will use the nine important steps of the procurement process namely information search, requisition request, approval, purchase order, delivery receiving (tracking) and payment, and identifying sourcing opportunities, negotiate, and contract [12]. As e-Procurement comes in various forms, assessing the intensity of e-Procurement can help identify what the public sector agencies are doing with e-Procurement, what steps of the procurement process have been automated with e-Procurement technologies and how intensively each step of the purchasing process has been "e-enabled". Furthermore, it is important to various e-Procurement adoption practices as public sector agencies may have different emphases for different steps of the procurement process that need to be automated with e-Procurement technologies. By differentiating the intensity of e-Procurement assimilation across the procurement process, it can be possible to link each domain of assimilation with its resulting dimension of procurement performance. This sort of approach can help the procurement organisation to better assess the impact of antecedent conditions that influence e-Procurement assimilation on the procurement performance.

The intensity of e-Procurement assimilation is the main dependent variable that is the aggregate measure of e-Procurement technologies implemented in the organisation for the conduct of procurement and the assimilation stages. This research has considered a number of technologies utilized including e-Procurement system (third party or in-house), electronic catalogues, electronic marketplace, electronic auction/reverse auction and, electronic tendering. The intensity of e-Procurement assimilation also captures

the concept of assimilation stage [8] for each e-Procurement technology. Furthermore, the intensity of e-Procurement assimilation also quantifies the penetration of each of the e-Procurement technologies to determine the level of support for the transactional and strategic procurement functions. It is important to aggregate these measures to determine the intensity of e-Procurement assimilation in terms of the number of e-Procurement technologies, the extent of their usage and their support for each transactional and strategic procurement activities of the organisation.

The assimilation process that includes adoption, implementation and routinization [19], [22] has been modeled as containing the six stages: i) Intention to implement; ii) Evaluation or Pilot use; iii) Commitment iv); Limited deployment; v) Generalized deployment [8]; and vi) Rejection [23]. The sixth stage can be justified by the authors' arguments that the implementation of an innovation can not be considered successful even if it survives through the deployment stage, as the innovation may ultimately be rejected by its users [23]. Together, these three dimensions provide an e-Procurement intensity index that signifies how many e-Procurement technologies are being used in an organization, to what extent these technologies are being used, and in which stage of the procurement process. In particular, a thorough understanding of e-Procurement assimilation necessitates that the assimilation be examined in both transactional and strategic activities, but the prior literature largely ignores strategic activities and does not examine several transactional aspects (e.g., delivery receiving). The transactional procurement activities included information search, requisition request, approval, purchase order, delivery receiving (tracking) and payment whereas the strategic procurement activities included identifying sourcing opportunities, negotiate, and contract [12].

An aggregate strategy has been chosen to represent these three dimension in order for the findings to be more robust and generalizable [9]. The following six conditions as identified by Fichman [9] that favor aggregation of technologies in the context of this paper are: i) our main interest is to develop a model that generalizes to the e-Procurement class, as opposed to a specific e-Procurement technology such as e-Marketplace; ii) antecedents are posited to have an effects in the same direction in the assimilation stages of a number of e-Procurement technologies ; iii) characteristics of organizations can be treated as constant across the e-Procurement initiatives within the Australian public sector; iv) e-Procurement characteristics cannot be treated as constant across the Australian public sector agencies; v) the innovation in this study (i.e., e-Procurement) can include substitutes or moderate complements and; vi) sources of noise in the measurement of the procurement performance because of e-Procurement may be present.

II. 1 Diffusion of Innovation

A substantial literature exists that investigates Inter-organizational information systems (IOS), and IT adoption,

diffusion and use (e.g., [1]; [13]; [21]; [14]; [10]). As discussed above, the assimilation of e-Procurement initiative can be an issue of technology diffusion and adoption of innovation. Obviously, innovation diffusion theory [24, 25] can be used to understand e-Procurement assimilation as the theory has also been extensively used recently as a fundamental theoretical base of innovation adoption research in the field of IS/IOS. As the adoption of e-Procurement as an innovation generates uncertainty, the procurement organization must be aware of the relative advantage and risk of implementing such innovation. Although the attributes suggested by IDT include relative advantage, compatibility, complexity, trialability, and observability [24, 25], only two variables – relative advantage (i.e. degree to which an innovation is perceived as being better than the idea it supersedes) and compatibility (of an innovation with existing practices and values) have been consistently found to be positively related and only variable – complexity (i.e. degree to which an innovation is perceived as relatively difficult to understand and use) has been consistently found to be negatively related to adoption of innovation [28]. As the different public sector agencies with different adoption intensity can perceive the characteristics of an innovation differently, Downs and Mohr [7] suggest taking perception-based characteristics of innovation into account rather than the inherent characteristics of the technology that do not vary across settings and organizations. Figure 1 below presents the research model.

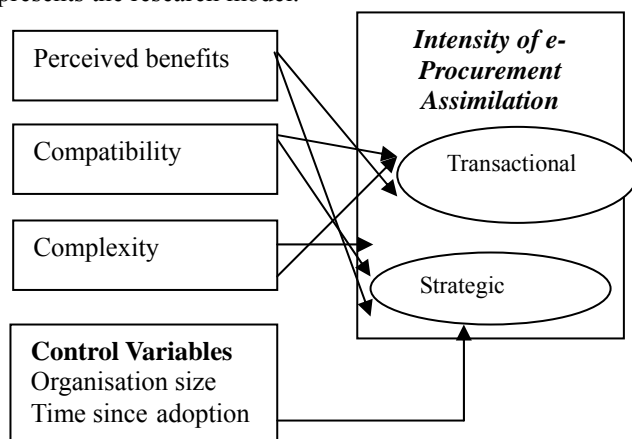


Figure 1: The Research Model

II. 2 Perceived Benefits

Perceived benefits refer to the anticipated advantages that an innovation can provide to the organisation. A number of studies have found that perceived benefits significantly impact IT adoption (e.g., [5], [2], [21], [16]). As organizations are motivated by the perceived benefits from the adoption of an innovation [16], they realize the need to use the technology fully and integrate it with existing applications [21]. Once the organizations are convinced of the relative advantages, they tend to allocate the managerial, financial and technological resources necessary for adoption

[2]. The availability of the necessary resources including the technical infrastructure also facilitates higher technical knowledge, which in turn increases the use of assimilation [5].

Relative advantage is apparent in the form of increased efficiency [24]. While Kalling and Cadeerskold [18] argue that e-procurement does not replace an existing system (but is rather a complement to existing ones, i.e. binary), the practitioner literature has reported the relative advantage of e-Procurement in various contexts. For example, according to the recent e-Procurement Benchmark report by the Aberdeen Group [20], organizations have been able to reduce off-contract spending by 64%, requisition-to-order cycles by 66% and requisition-to-order costs by 58%. The use of the Internet, the open standard, and the web technologies are such strengths of e-Procurement technology that contribute to interoperability. Interoperability promotes integration, however, also poses risk and security threats when organizations integrate e-Procurement systems with other internal information systems. Hence it can be hypothesized that:

H1a: Greater the extent of benefits of e-Procurement, greater will be the intensity of its transactional assimilation in the organization.

H1b: Greater the extent of benefits of e-Procurement, greater will be the intensity of its strategic assimilation in the organization.

II. 3 Compatibility

Compatibility of an innovation can be thought of as the organizational fit of the system introduced [19]. It is the degree to which the innovation is perceived as being consistent with existing financial and accounting systems, procurement practices and the e-Procurement implementation strategy and procurement policies and guidelines of the organization. This approach provides us with an opportunity to identify the different types of compatibility – technological and organizational. E-Procurement might require changes in the existing stages of the procurement processes and practices and might introduce new or reduced stages to complete the purchase-to-pay cycle. According to Premkumar and Ramamurthy [21], compatibility of the new system with existing work procedures increases the likelihood of adoption and this is also true in the case of e-Procurement. Hence it can be hypothesized that:

H2a: Greater the extent of compatibility of e-Procurement, greater will be the intensity of its transactional assimilation in the organization.

H2b: Greater the extent of compatibility of e-Procurement, greater will be the intensity of its strategic assimilation in the organization.

II. 4 Perceived Complexity

Rogers [25] has defined perceived complexity as the degree to which an innovation is perceived as relatively complex to

understand and use. As the assimilation of e-Procurement as an innovation generates uncertainty, the procurement organization must be aware of the relative advantage as well as the risk of implementing such innovation. As the assimilation progresses, Teo et al. [27] note that the heightened knowledge gap between the current requirements and the current resources creates a higher sense of uncertainty about the innovation for the organization. Based on Zaltman et al.'s [31] classification, two levels of complexity can be identified. First e-Procurement implementation may contain complex ideas, i.e., e-Procurement may be difficult to understand from a business as well as technical perspectives. Second, using e-Procurement may be difficult to understand and visualize the whole process of procurement-to-pay (P2P). It is also important to note that ease of use is an important indicator of information systems success [6]. Hence it can be hypothesized that:

H3a: Greater the extent of perceived complexity of e-Procurement, lower will be the intensity of its transactional assimilation in the organization.

H3b: Greater the extent of perceived complexity of e-Procurement, lower will be the intensity of its strategic assimilation in the organization.

III. Research Methodology

Initial feedback on the survey instrument was sought from ten academic experts at the Australian, UK and US universities. The initial structured questionnaire was generated based on the pilot study with Procurement/e-Procurement managers involved in the implementation of e-Procurement, and academic and practitioner-oriented (government reports) literature. A total of 40 professionals from the five states of Australia including the agencies that are actively involved in the implementation of e-Procurement such as Centrelink, Australian Government Information and Management Office, Standards Australia, SmartBuy (NSW), Australian Antarctic Division (AAD), CSIRO etc. participated in the study. The comments were sought on the length, completeness and readability of the survey and each item was reviewed for content, scope and purpose. Results of the pilot study were used to assess the content validity of the measures. Although the participants indicated no major modifications with regards to the conceptual model and the antecedent conditions for e-Procurement assimilation, however, a number of important comments were incorporated in the instrument development and wording/consistency of the questionnaire items.

A five-point Likert scale was used to collect the response. The preliminary version of the questionnaire was pre-tested during the qualitative pilot study (email communication, informal interviews). Iterative refinements were made to the preliminary version and the final version of the questionnaire consisted of nine items for the two constructs. Since the time period was still early in the early stages of e-Procurement in organizations, the public sector agencies

were chosen opportunistically – that is, the researcher sought the agencies that have implemented or were beginning to implement e-Procurement, rather than to seek a representative set of firms who were both adopters and non-adopters of the technology.

Respondents were asked to indicate the extent of their organisation's level of e-Procurement use in terms of overall procurement transaction on the scale of "No intention to implement", "Intention to implement", "Evaluation or Pilot use", "Commitment", "Limited deployment", "Generalised deployment" and "Rejection". Respondents were also asked to indicate the predominant e-Procurement technology among the e-Procurement technologies through which their organisation uses (or plans to use) to conduct procurement in terms of overall procurement transactions. In order to assess whether the e-Procurement assimilation was transactional or strategic, respondents were asked to indicate the procurement activities that are supported by e-Procurement in their organizations. The transactional procurement activities included information search, requisition request, approval, purchase order, delivery receiving (tracking) and payment whereas the strategic procurement activities included identifying sourcing opportunities, negotiate, and contract [12]. Control variables included the size of the organisation - measured in terms of organisation's annual direct and indirect procurement expenditure for the last financial year, and assimilation gap which was measured by asking the respondents when their organizations first adopted e-Procurement.

Overall navigation of the survey website was designed to be linear, as simplified as possible. Respondents were required to indicate the name of their organizations or divisions/units. Following the suggestions of Couper et al. [4] to avoid checkboxes in academic web-based research, radio buttons were used instead. A federal government agency, the Australian Procurement and Construction Council (APCC) agreed to endorse and administer the survey, which is supposed to generate a greater response rate. Also, as with any survey research, response bias is always a concern, however, given the arrangements in regards to the administration of the survey, it can be anticipated that misleading responses will not be submitted by the professionals of the government agencies (members) who are usually aware of the accountability and ethical issues.

IV. Data Analysis and Results

Given the cross-sectional nature of this research, correlation and regression analyses [3] will be completed using the statistical software package SPSS 13. While the correlational analyses will be used to support (or reject) the hypotheses, consistency will be ensured by taking into account the regression analyses that regression results can categorically reject such support. Furthermore, testing the measurement model will involve examining the internal consistency (Cronbach's α), convergent validity (factor loading), and discriminant validity (correlations) of the constructs. It has

not been possible present the analysis of complete set of data as only 70 responses have been received at the time of writing of this paper, however, we will come up with the results of this research when submitting the camera-ready version of the paper.

V. Conclusions

This paper has both academic and practitioner implications. Academically, this paper has proposed an e-Procurement assimilation model which draws its insights from both the literature on diffusion of innovation adoption as well as from e-Procurement research on organizational assimilation. Such a model can be hoped to explain the interplay among organizational context variables, attributes of managers' implementation strategies, and other characteristics that, in aggregate, shape assimilation process and outcomes of e-Procurement initiatives in the public sector. By developing a clearer connection between existing theory and apparent most relevant factors, a richer, more generalizable understanding of the antecedent conditions influencing the e-Procurement assimilation and its impact on the procurement performance is likely to emerge. By dividing procurement activities into transactional and strategic phases, we are able to distinguish the impacts of antecedent factors on different phases. Such an approach also enables us to evaluate if the same e-Procurement antecedents impact procurement performance in the organizations differently in the two phases. From the practitioner point of view, since the phenomenon under investigation is still in early stages, our research has considerable practical implications for procurement professionals and e-Procurement project managers. This study presents the critical antecedent conditions that influence the extent of e-Procurement assimilation. It can be expected that the procurement professionals and e-Procurement project managers in the public sector can influence and manage the e-Procurement assimilation in light of these antecedent conditions.

While the Diffusion of Innovation Theory is still relevant for the study of e-Procurement adoption and implementation, Gallivan [11] suggests that these theories only focus on the individual level adoption of innovation and neglect the realities of implementing technologies in the organizational level. Similarly, Jenkins-Smith & Sabatier [17] maintain that stage models operate without a causal motor, i.e. they lack identifiable forces that drive the policy process from one stage to another. Given these limitations, it is necessary to study the subject of e-Procurement assimilation and our future research in this regard will be focused on using other theoretical bases such as institutional theory and resource-based theory in order to identify further antecedent conditions that may influence e-Procurement assimilation. Another limitation is that this study represents a "snapshot" view of this phenomenon. A longitudinal study would provide more insight. Also, expanding the study

to other industries would provide a more generalizable and robust examination of the hypotheses.

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E-Procurement – Process Based Conceptual Model

Jaroslav Jandos
University of Economics
Faculty of Informatics and Statistics
W. Churchill Sq. 4
13067 Prague 3, Czech republic
Tel: (+420) 224 095 457 fax: (+420) 224 095 456
E-MAIL:jandos@vse.cz

Abstract: This paper aims to contribute to the development of a process based conceptual model of electronic procurement. Model is based on three basic e-procurement processes – strategic, tactical and operational e-procurement. Processes are divided into phases which are supported by applications (i.e. software programmes). Apart from applications supporting basic procurement activities there is a currently fast growing group of ADM (Analytical - Decision support - Management) applications, which brings business benefits especially in complex procurement environments. The basic view is that of ICT's (Information and Communication Technologies - namely Internet, Internet technologies, Internet standards, Internet applications) support of procurement activities. Paper presents integrated e-procurement applications and also various integration requirements of e-procurement applications. Model may perhaps help enterprises, which are new to e-procurement, e.g. SMEs, to gain basic understanding of which applications may be used for implementation of e-procurement processes.

Keywords: e-procurement, e-auction, e-tendering.

I. Introduction

Procurement refers to the processes used by buying party in locating, purchasing and moving materials from suppliers to the buyer's point of need [19]

Procurement (of direct materials) is also an important part of SCM (Supply Chain Management). SCOR (Supply Chain Operation Reference) model, i.e. system of process definitions for SCM, consists of four elementary process types – plan, source (i.e. procurement), make, deliver [20], [7].

Procurement concerns two types of materials

- direct (production) materials i.e. raw materials, components, production-oriented services, products, which become parts of finished product/service or are further sold to company's customers
- indirect (non-production) materials i.e. materials which are not part of product/service, which is produced and sold by the company. Typically MRO (Maintenance

Repair and Operating) supplies – laboratory equipment for research, computer HW and SW, leased cars, office equipment, food for catering, cleaning - and non-production services

Both material types have different characteristics, as seen from table 1 (modif [6], [10]). These characteristics influence the e-procurement (EP) solutions for direct and indirect materials.

Several definitions of e-procurement (EP) have been presented e.g. [16], [18]. Our definition is the following:

E-procurement is implementation of procurement functionality for direct as well as for indirect materials/services using application software (applications). In modern e-procurement, which is subject of our paper, Internet, Internet-related standards, Internet (web) applications or services are used.

As in many other application areas, also in e-procurement ICT are used for electronic processing (as opposed to manual processing), process automation, as stimulator of process modifications, means of communication, information sharing and coordination among all participants as well as for internal as well as for external integration [19].

Implementation of e-procurement is influenced by many factors and developments in ICT/IS area. The basic ones are the following

- use of Internet (for business support) – global communication network, environment for internet-applications
- applications architecture – from monolithic via client/server to Web-enabled client/server to SOA (Service Oriented Architecture)
- ERP developments – in functionality, internal architecture, integration means, means of user communication with ERP
- e-marketplaces developments – functionality, ownership [8], [12]
- integration solutions – namely data and application integration, inter and intra-enterprise integration, modern integration technologies SOA (Web service) oriented [9].

II. Process-Based E-Procurement Conceptual Model

II.1 Introduction

There is a large body of literature describing in various extent e-procurement processes, mostly tactical and operational EP. Various references use different phases of processes, different terminology and different “width” of description – processes are typically used as basis for analysis of different EP attributes. Boer [5], whose main aim is to assess the impact of e-procurement, presents six “forms” of e-procurement. Knudsen [11] presents process descriptions based on seven steps of business procurement life cycle by Archer and Yuan [3], as well as on e-procurement applications based on Boer’s “forms”. Davilla [4] presents e-procurement “models”, which are basically the e-procurement technologies in our view and discusses also barriers to their utilization. Both Turban [21] and Puschmann and Alt [17] present a short view of e-procurement processes, as basis for their further analysis of other aspects of EP. Weele [22] presents comprehensive description of procurement processes, with different process phases than our EP model. Aberdeen Group [1], [2] has been for many years active in e-procurement research, analysis and methodologies. Based also on references mentioned above the aim of this paper is to contribute to the development of EP process based conceptual model.

Our process-oriented conceptual model (framework) of e-procurement is oriented at buyer-executed activities. From institutional point of view the buyer may be

- enterprise (business) – because of specifics from the EP point of view often SMEs and “non-SMEs”, i.e. larger enterprises, are distinguished
- public administration
- In this paper we take the enterprise’s point of view.

Two basic ways of procurement (buying), from buyer’s perspective are

- contract – based (systematic) buying, based on long-period contract – which is the basis for partial deliveries (transactions) i.e. repeated execution of operational EP process. This way is subject of our paper
- spot buying without a priori contract. Includes one delivery (transaction) i.e. only one execution of operational EP process. With ICT support this way may be implemented
 - in case of fixed prices by e-catalogues located at supplier site or at 3rd party sell-side vertical procurement portal
 - in case of variable prices by direct Internet auctions at B2B auction sites or B2C auction sites (for some indirect materials)

Presented conceptual model, see fig 1, consists of three hierarchical levels of e-procurement processes. Process position in the hierarchy is determined by the strategic importance of activities implemented in the process. The processes are the following

- strategic EP process
- tactical EP process

- operational EP process

Dotted lines in fig.1 depict conceptual business strategic impact.

All EP processes are supported by ICT, especially by Internet, internet applications and internet technologies. Processes are divided into phases, which are further divided into steps. Functionality of individual steps is implemented by applications, i.e. software products/programmes) in relation to organizational, personal and other aspects. The application may concern, i.e. to implement processes of, several steps and also more applications may concern, i.e. to implement processes of, only one step of EP. Most EP applications are web-based client/server applications with light client i.e. web browser. At strategic and tactical level the ICT-supported processes, presented in this paper, are not considered to be substitutes for other (i.e. non ICT) activities as personal dealings, use of traditional information sources etc, but rather as enhancement of EP activities.

Strategic EP process is sub-divided into following phases

S1 – EP strategy formulation

S2 – EP strategy update

Tactical EP process is sub-divided into following phases

T1 - Requirement specification

T2 - Determination of the way of requirement solution

T3 - Suppliers identification and selection

T4 - Contracting

Operational EP process is sub-divided into following phases

O1 – Ordering

O2 – Delivery acceptance and payment

Operational EP process is executed for every partial delivery (transaction), in the scope of valid contract negotiated between buyer and seller in tactical EP process (i.e. systematic buying) or is executed only once for spot buying.

Typical EP scenario, i.e. systematic buying, which is considered to be typical for EP, is the following: in tactical EP process contract for given material with (the most convenient) supplier is signed. By repeated purchases (i.e. repeated instances of operational EP process), the partial purchases (transactions) are realized – in scope of signed contract.

Tactical and operational EP processes are event-initiated (apart from typical events given below there may be a big scope of specific events)

- tactical EP process – initiated typically by determination, at enterprise level, of long-term need for material, for which there is no supplier selected and no contract signed
- operational EP process – initiated typically by determination of immediate need for material, for which there is contract signed with selected supplier, i.e. partial deliveries in the scope of this (long-term) contract

Initiating event may be

- employee (end-user) needs material, typically indirect material e.g. MRO – mobile phone, and requires it by DPS (Desktop Procurement System) [15]
- need of direct material is determined by production planning application, which is a part of ERP system (i.e. MRP Material Resource Planning) or by SCM (Supply Chain Management) application. Operational EP process is initialized, which may be (in the case of direct material) executed by (preferably web-enabled) ERP applications or by SCM application

Our conceptual model does not include some phases, included by other sources i.e. quality control [21] or product consumption, maintenance and disposal [3].

Several steps of tactical and operational EP include means for EP coordination and collaboration, typically based on message transfer and (in some cases) on mutual access to information (databases). Coordination [19] involves the sharing and exchange of relevant information both internally as well as externally i.e. between enterprise and its business partners. Issues of coordination and collaboration are not detailed in our model.

Unified terminology in procurement and especially in e-procurement area is far away at the moment with various subjects, i.e. consultants, analytical corporations, users, solution providers, using different synonyms. „Tactical EP process“ is often called „sourcing process“ or „e-sourcing“, „operational EP process“ is often called „purchasing process“ or „e-procurement“. „E-sourcing“ sometimes include only the phase of selecting potential suppliers

Integration is an important issue of EP. Application integration is mostly used as well as data integration (typically for analytics, see 2.5.). In EP there are various ways of application integration, namely

- EP applications with inter-enterprise applications related closely to procurement processes (i.e. with some ERP applications and other inter-enterprise applications)
- (between) Individual EP applications, creating “integrated EP applications”
- EP applications (or users) with external applications, as with
 - Applications/IS of suppliers
 - Applications of intermediaries, which implement some steps of EP processes e.g. e-marketplace
 - Applications of ASP, which implement one or more phases of EP processes as service

For given EP implementation the degree of integration, measured basically by number and also by business scope of integrated application, may be

- null, i.e. only isolated EP applications is used, e.g. real-time Internet auction
- significant, i.e. several EP applications are integrated into “integrated EP application”. Typical examples
 - DPS (Desktop Purchasing System) application -

integrating basically all functionality of operational EP for indirect materials,

- e-RFx-based application – integrating e-tendering (including RFx creation), e-auctions (typically Internet online reverse auction) including supplier selection, which is one of modern EP integrated applications

SRM (Supplier Relationship Management) application – integrating most of inter-enterprise functionality for tactical and operational EP.

II. 2 Strategic EP Process

This process, oriented towards formulation, control and modifications of EP strategy, consists of two phases

S1. EP strategy formulation

Result from this phase is EP strategy, which is a part of enterprise’s procurement strategy. It is based on enterprise’s current level of procurement and on current level of ICT use. Based on enterprise’s procurement strategy and with the aim to support enterprise business goals, EP strategy specifies especially

- which EP processes/applications are used, e.g. to support procurement of various materials (or groups of materials)
- strategic criteria used in EP processes e.g. criteria for supplier selection
- ICT participation in analytical, decision supporting and corresponding management activities
- which EP applications are hosted by enterprise and which are hosted by 3rd party (i.e. outsourced)

S2. EP strategy update (modification).

Is process of EP strategy modification, executed according to significant changes in business or IT environment as well as according to EP results so far.

II. 3 Tactical EP Process

In this process applications executing procurement functionality as well as AMD applications (see 2.5) and supporting services are used. AMD applications’ functionality goes well beyond automated tactical procurement and brings additional benefits. Process phases and their steps are the following

T1 - Requirement specification

Result from this phase is specification of requirement, typically log-term, for given product. This specification includes [22]

- functional a detailed technical specification
- quality specification
- logistic specification (e.g. delivery period)
- delivery volume (e.g. in pieces), target budget
- some other specifications, depending on industry

For direct materials this specification is included in product specification, based on BOM (Bill Of Materials), for indirect materials is set up by procurement officer.

T2 - Determination of the way of requirement solution

In this phase the tactical solution, which is in accord with EP strategy, is selected for fulfilment of requirement specified in phase T1. Two points of view are taken into consideration

- business – i.e. which benefit is expected (e.g. lower cost, short delivery period), way of delivery solution – spot buying, long-term contract, expected length of contract, specific criteria for supplier selection (e.g. if strategic supplier is being selected), whether one of current suppliers or new supplier should be selected etc.
- technological (ICT) – which ICT means (applications, their integration, communication environment etc.) in which EP processes will be used for requirement fulfilment.

T3 – Suppliers identification and selection

Result from this phase is selection of one (i.e. most favourable) supplier for fulfilment of the requirement. Contract with this supplier is signed in the following phase T4. Steps in this phase are not executed sequentially; particular steps are selected by buyer.

In this phase electronic request for information (RFI), request for proposal (RFP) and request for quote (RFQ) – commonly called e-RFx, as well as online reverse auctions and other applications, e.g. AMD applications as advanced bid analytics, are often used. RFP and online reverse auctions represent widespread online negotiation methods.

This phase is divided into two sub-phases

- suppliers identification – is the process of identification of potential suppliers (for given material or group of materials),
- supplier selection - is the process of evaluation of potential suppliers according to buyer specified criteria/requirements and selection of (typically) one supplier. Under specific circumstances more suppliers may be used for given material. For simplicity reasons we don't consider this situation

Sub-phase: suppliers identification

Step: information gathering

Is the process of market research, used for identification of potential suppliers, based on information gathering mostly from external sources, in significant part using Internet technologies.

The following sources/applications are used

- web-sites of potential suppliers
- internet search engines, internet portals
- internet supplier catalogues – at internet portals, e-marketplaces, specialized internet suppliers catalogues
- 3rd party services (“sourcing services”), accessible by Internet - for recommendation of possible potential suppliers. 3rd party with significant supply category expertise and know-how of given vertical market (and possibly own thorough evaluation of potential suppliers)

may recommend potential suppliers for given category/material. In some cases the service may include also hosting and consulting of all remaining steps of phase T3, resulting in selection of one (final) supplier.

Step: contacting suppliers

Is the process of contacting suppliers in order to get more info needed for their basic evaluation. Buyer asks suppliers to fill standard electronic RFI (Request For Information- eRFI) sent by e-mail or published on buyer web-site, which is evaluated in the next step.

Step: suppliers review

Is the process of performing general evaluation of potential suppliers, based on available information, by buyer qualification criteria e.g. financial stability, references, manufacturing facilities, material characteristics etc. Suppliers references may be verified by contacting supplier's customers and product samples may be tested by buyer. Result of this step is a list of potential suppliers, used in the next sub-phase. Internet is used often as communication media and information source

The following sources/applications are used

- suppliers web-sites (annual reports etc.), internet news servers (news, analysis), vertical information/procurement portals
- 3rd party services, accessible by Internet - for verification of supplier credibility, economic strength etc, (e.g. Dunn&Bredstreet)

Sub-phase: supplier selection

Step: e-tendering

Is the process of supplier selection in case of dynamic prices. It is executed in the following steps

- buyer publishes on Internet his requirements for bid (offer) for material delivery from potential supplier in the form of standard electronic RFP (Request For Proposal) or RFQ (Request Of Quote). Often buyer reduces access to RFP/RFQ to pre-selected (in previous sub-phase) potential suppliers.
- Interested potential suppliers submit, till the given date, their electronic bids (offers) in structure specified by buyer by Internet (e.g. to buyer web-site or by e-mail)
- this step often includes also bids analysis, comparison and assessment. Bids are typically in electronic standard structure, may be in XML format. Therefore semi-automatic multi-criteria supplier selection may be implemented. Criteria specified in RFP, price in bid and other criteria are used. The result of this step is either selection of one supplier, which satisfies best the given criteria, or selection of several “good” suppliers, from which the best is selected in the next step e.g. online reverse auction.

Step: e-auctions

Is the process of supplier selection in case of dynamic prices by use of internet auctions. From EP point of view the internet auctions are classified according to two criteria

- (algorithm) mechanism of auction criteria determination
 - o direct auction – during auction process the auction criteria (typically price) is increased
 - o reverse auction – during auction process the auction criteria (typically price) is decreased
- length of time of auction execution
 - o “standard” auction – executed during several days or several weeks
 - o real-time (on-line) auction – executed during few hours. During this time period all potential suppliers participate in auction process (are on-line connected over Internet or react by e-mail). All participants are “pre-selected” (e.g. by e-tendering), so that they satisfy all buyer’s requirements.

Reverse real-time Internet-based auctions, which are often used in EP, may be classified

- by type of materials bought
 - o single material auctions
 - o multiple materials auctions
- by number of attributes included into auction evaluation
 - o single attribute auction (typically price)
 - o multi-attribute auction, including also other attributes than price

As the (final) supplier, the one who satisfies best given criteria is selected.

Internet auction may be implemented on

- buyer web-site
- e-marketplace, supporting this functionality
- 3rd party web-site, supporting e-auctions. For spot buying typically direct auction at B2B auction sites, or (for SMEs also) at B2C auction sites
- 3rd party web-site, which is used only for real-time auctions, typically reverse auctions for systematic buying

Step: e-aggregation

Is the process of supplier selection based on aggregation of (partial) demands of various buyers into aggregated demand, which is then published (on Internet) for potential suppliers as electronic RFP, RFQ. By demand aggregation typically the lower price can be reached. This process is used only to limited extend, mostly for commodities.

E-aggregation is implemented on

- e-marketplace, supporting this functionality, typically consortia e-marketplace. There is a limited number of e-marketplaces supporting aggregation.
- 3rd party web-site, with specialisation at aggregation

Step: e-negotiation

Is the process of buyer negotiation with potential suppliers with the aim to reach the agreement on the contract between buyer and supplier under complicated conditions, when above mentioned approaches (i.e. e-auctions, e-tendering), which often include supplier’s a priori agreement with important contract conditions proposed by buyer, cannot be used.

Process is based on Internet use as communication media and often on use of DSS applications for support of negotiation management and evaluation of results. These applications are relatively new, used in limited extent.

Final signing of contract is not part of this step.

T4 – Contracting

The result of this phase is contract signed by two parties – buyer and supplier, which is also a basis of partial demands/deliveries (transactions) executed in operational EP process.

This phase is supported by CMS (Contract Management System) application (see section 2.5.) and typically by buyer specific ADM applications, often Excel-based.

II. 4 Operational EP Process

This process is started by recognition of immediate need for material for which (typically) contract was already signed (i.e. systematic buying). Process consists of two phases which are executed sequentially.

Applications supporting both phases of operational EP are typically integrated into one integrated application, supporting whole process of operational EP. Basic differences between procurement and operational processes for direct and indirect materials appear in table 1.

	Direct materials	Indirect materials
Order size	Large lots	Often small
Percentage of total spend (typical)	80%	20%
Percentage of total numbers of purchase orders (typical)	20%	80%
Scheduled by	Production runs	Not scheduled, ad hoc
Locus of operation	Professional buyer’s desktop	employee desktop
Driven by	Design specification	Catalog-employee selection
Approval	Not required	Required
Degree of automation	High	Low (often no automation)

Table 1: Procurement of direct versus non direct materials.

On these differences the differences between integrated applications for direct and indirect materials are based. Integrated application for indirect materials provides functionality, i.e. requirement generation by end-user, material selection from catalogue, requirement approval, which is not required for direct materials. This is the main reason for separated solutions (applications) of operational EP for direct materials and operational EP for indirect materials

- operational EP for indirect materials – provided by integrated application DPS
- operational EP for direct materials – provided by integrated application Web-ERP (i.e. ERP with web-browser interface) including integrated ERP applications e.g. MRP for operational procurement planning, eventually with integration of SCM application (especially for strategic and tactical EP planning)

Operational EP process for indirect materials is described below.

O1 – e-ordering

This phase is divided into two steps

Step: requisition creation

Requisitions for direct materials are typically automatically generated by MRP or APS application, including order generation and it's sending to supplier by agreed upon communication channel (Internet, EDI etc.)

Requisitions for indirect materials are generated by end-user (employee) using multi-supplier e-catalogue for materials selection, by means of web-browser. Only materials already contracted with all suppliers are listed in catalogue. The result of this step is electronic requisition for material, which is automatically passed to next step.

The catalogue should always contain complete and actual information. Therefore its content management and its location are of importance.

Buyer may use the following catalogue organization and location

- integrated multi-supplier catalogue, located at buyer IS (web-site)
- integrated multi-supplier catalogue, created and maintained in 3rd party system (e.g. e-marketplace), i.e. outsourcing from buyer's point of view
- partial catalogues located in systems (sell-side web-applications) of individual suppliers and accessible by Internet

Step: requisition approval, order generation, sending an order to supplier

Electronic requisition, created in previous step, is automatically passed to proper managers for approval. By definition of requisition rules (and financial limits for employees) the number of approval steps can be limited or excluded at all. These activities are executed by (application)

workflow management system. Standard purchase order is automatically created from requisition, including integration with corresponding ERP applications (e.g. purchasing, accounts payable). The result of this step is electronic purchase order, sent to supplier by some communication/integration technology as e-mail, fax, EDI, XML message.

O2 – Delivery acceptance and payment

This phase is divided into three steps

Step: delivery monitoring (by buyer)

By use of ICT buyer can monitor the state of delivery i.e. if it is being completed, if it has been expedited already etc. Immediate state of delivery can be monitored at supplier web-site or at logistic firm's web-site in case the logistic operations has been outsourced by supplier.

Step: acceptance of delivery and of supplier's invoice

Material is delivered to buyer, who executes the corresponding activities in corresponding applications, typically in ERP applications e.g. accounting, inventory. Invoice is then sent to buyer. Supplier may use ICT for electronic invoicing (e-invoicing). Electronic invoicing is the transmission and storage of invoices by electronic means, without the delivery of paper documents. For electronic invoice integrity and authenticity have to be provided (e.g. by EDI, electronic signature). This step executes buyer's activities following invoice acceptance, provides comparison of invoice with accounts payable and approval of invoice discharge by automatic workflow. The result of this step, which is executed in significant degree automatically, is authored payment order.

Step: e-payment

Based on payment order the payment by electronic means, typically through a bank, is executed in this step. EDI, electronic banking is used. Other progressive means to limited extent. For increased process efficiency buyer's electronic self-billing can be used.

II. 5 EP ADM Applications

These ADM (Analysis-Decision support-Management) integrated applications enhance EP functionality (mentioned above) in one or in more steps of EP processes. Some applications, e.g. TCM, go far beyond the scope of procurement. In these applications analytical functionality is typically closely integrated with EP decision support and EP management functionality. Data are extracted from various, mainly internal procurement related (typically operational EP related) sources. Advanced analytical methods are used, known as well as "Business Intelligence" e.g. data mining, neural networks, as well as various optimisation methods, valuable especially in situations with multiple variables. Partial applications support above mentioned EP processes as well as new specific processes e.g. analytical processes.

These applications are offered under various names

(“labels”), accenting analytical or management functionality. It is in this area of EP applications where is the greatest pace of new developments at present. Forester’s forecast of worldwide revenues for EP related software [14] predicts bright future especially for spend analysis (management) and also for contract life-cycle management applications.

ADM applications are event-initiated and may be executed either periodically or on as need basis. They support execution of tactical and strategic e-procurement processes.

Typical ADM applications are the following

Bid analysis

Application is used for simultaneous negotiations and evaluation of complex bids. Optimisation may be used for solution of multiple variable problems within given constraints. Application is used typically in phase T3.

Contract Management System

This integrated application includes applications (tools) and processes for contract life cycle management – contract formulation, contract execution/use, contract termination. Analytics applications – analysis of supplier performance, analysis of contract compliance (which is an important instrument for enterprise to fully implement savings negotiated in contract) – are often integrated into this application. Application of DMS (Document Management System) is used for creation and management of archive of all documents created during contract life-cycle. Data for contract compliance (by buyer) are extracted also from related applications e.g. ERP. Analysis of contract compliance by buyer is typically executed, while contract compliance by supplier is typically part of supplier analysis integrated application (see below). CMS is used in EP tactical process, typically for support of step T4.

Spend analysis (and management)

This integrated application is oriented towards

- extraction of procurement related data from various sources (ERP, EP applications)
- classification of this data, using various BI analytical methods, into typical categories - material category, division, supplier, employee
- automated data analysis from different perspectives related to various EP processes and supporting applications – tactical EP, contract compliance management, supplier management, EP strategy and procurement strategy. Use of this application provides measurable benefits in all these areas.

Basic aim of this application is to provide in-depth quantitative view of how the company spends procurement money, typically on global company basis.

Category spend analysis (and management)

This application is basically a subset of “Spend analysis”, oriented towards one product category.

Supplier performance analysis (and management)

Application is used for analysis of supplier performance against his contractual obligations, based on standardized metrics. Results are typically used for supplier management e.g. in negotiations with suppliers e.g. contract renovation and for possible modification of procurement and EP strategy in area of supplier selection.

Total cost management (TCM)

TCM is managerial approach, supported by applications, of managing TCO (Total Costs of Ownership) of all enterprise supply-related costs. In TCO all costs related to materials, supply infrastructure, supply-oriented process execution, supply performance exceptions are included. For purpose of TCO enterprise organization, processes, knowledge and technologies are aligned. For effective execution of TCM-related activities proper technology infrastructure (ICT supported) as well as central data repository, containing all related enterprise-wide data, is needed. From applications point of view TCM is an “umbrella” integrated application, using most of EP functional as well as ADM applications. Included in TCM are tactical EP, operational EP, as well as ADM applications spend analysis, contract management, supplier performance measurement [1].

III. Conclusion

Numerous benefits of e-procurement have been cited in [4], [5], [10], [11], [15], [16]. Although various reasons have been cited for using EP by buyer, the main reason is typically costs reduction. The reason being that costs reduction goes directly into bottom line. Wyld [23] reports that almost half of all American companies use e-procurement applications. 30% of companies surveyed use e-procurement for RFQ, 25% use on-line auctions, 33% use e-marketplaces. Most companies use only one EP application. Use of integrated EP applications or several isolated EP applications hosted by company itself has been mostly limited to large (often multinational) companies, where the benefits e.g. costs reduction in complex environment of many suppliers and many items purchased, are significant. However Forrester [13] reports growing interest in outsourced, i.e. 3rd party hosted, EP applications and services. Because of lower front-up costs, outsourcing of EP application may be viable alternative even for smaller companies.

As seen from previous sections, possibilities of ICT support of procurement activities are quite numerous and taking into account its benefits we may expect continuous adoption of EP in the future.

Perhaps the presented conceptual model may help companies in getting systematic view of EP and its possibilities, taken primarily from EP’s support by ICT point of view.

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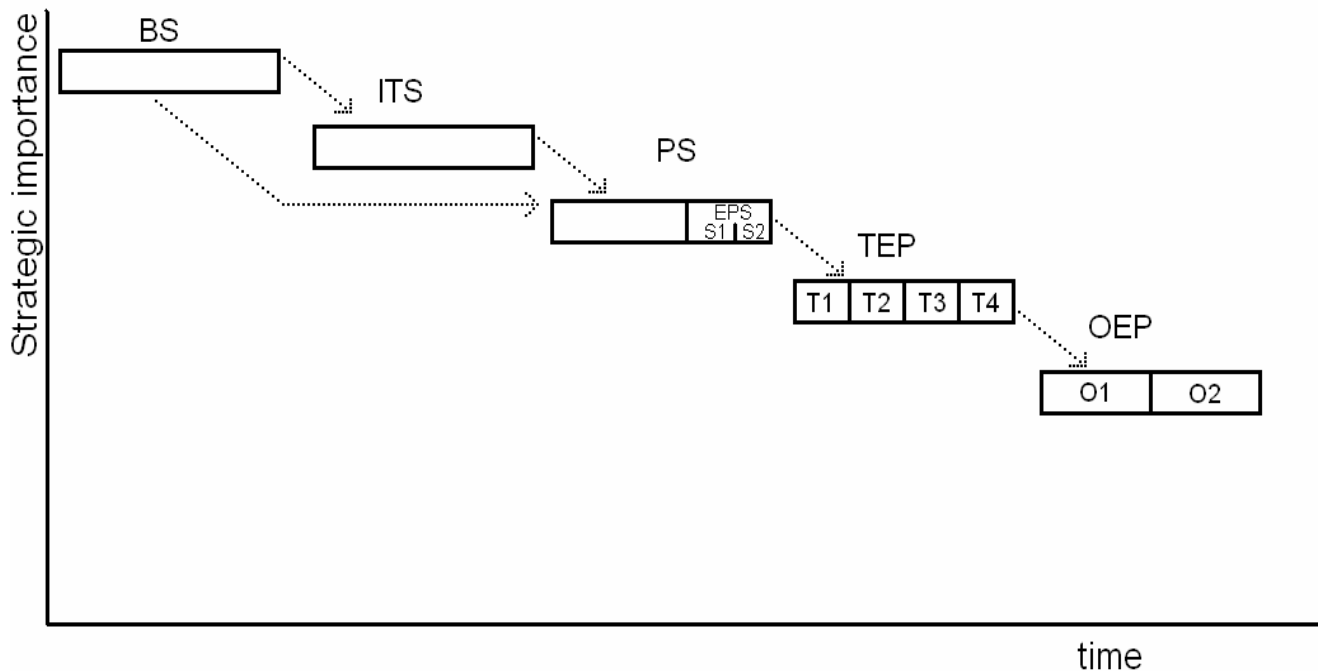


Fig 1.: E-procurement conceptual model

BS – Business strategy; ITS – IT Strategy; PS – Procurement Strategy; EP – EP Strategy; TEP- Tactical EP; OEP – Operational EP
...Basic business strategic impact

Analysis of Functionalities of Commercial Websites Used for Procurement: Implications on Design and Operations

Younes Benslimane, Zijiang Yang
York University, Toronto, Canada

Abstract: This research analyzes the functionalities of commercial websites used for electronic procurement and links them with the benefits as perceived by users and with relevant operations. Findings from a Data Envelopment Analysis (DEA) used on data collected from 88 corporate buyers working in a wide range of industries and using the World Wide Web to support the procurement process show that adding advanced functionalities to informational websites can reduce their efficiency, which suggest that commercial websites are more often used to reduce buyers' search costs than their processing costs. Possible explanations and implications of such findings on the design of commercial websites used for business-to-business transactions and on operations for both vendors and buyers are discussed.

Keywords: Operation strategy for e-commerce – DEA.

I. Theoretical Background

The World Wide Web has emerged as a promising medium for electronic commerce and thousands of "dot.com" and "brick and mortar" organizations have set up commercial websites to do business over the Internet [6] [14] [15]. The commercial websites hence deployed have the potential to support supply chain operations in general and procurement in particular [8]. Today, business-to-business transactions account for the largest proportion of the transactions conducted over the Internet.

Generally speaking, commercial websites can have four functionalities that support the procurement process [4] [13]. The identification functionality of commercial websites allows buyers to spot potential vendors of a given input. The selection functionality gives buyers an online access to pricing and other relevant information that allow them to compare different offerings and select a supplier for the pondered input. The execution functionality allows buyers to check the availability of a given input, place orders and make payments. Finally, the post-sale functionality allows buyers to track the status of their orders and of their shipments online.

Previous work has considered these functionalities as different stages of a growth model for commercial websites [16] [17]. Although their degree of integration to backend systems varies from one vendor to another, transactional websites can be considered as the last stage of development for a commercial website. The cost of developing and mai-

ntaining commercial websites increases as advanced functionalities are added, running anywhere between the tens and the hundreds of thousand dollars for a static website and anywhere between the hundreds of thousand dollars to millions of dollars for a transactional website [17] [19]. Typically, websites that only support the identification phase have the lowest cost whereas transactional websites are the most complex and the most expensive to develop.

The value of commercial websites can be assessed from the perspective of vendors who deploy such systems or of buyers who use them to support their procurement process. In general, advantages of electronic business-to-business transactions include operational and strategic benefits for both vendors and buyers [18]. In the specific case of electronic procurement, the identification and the selection functionalities of commercial websites can help reduce buyers' search costs as it becomes easier and faster for users to contact more potential suppliers and decide on the "best" one [2] [3]. The execution and the post sale functionalities can help users reduce processing costs for their transactions by eliminating paperwork, reducing data re-entry, improving information accuracy and reducing lead times [11] [18].

Depending on their functionalities, commercial websites can support, in whole or in part, electronic transactions. As a result, the availability and usage of such functionalities have different repercussions on vendors' and buyers' business processes hence supported and shaped. Business process redesign (BPR) refers to an information technology-enabled fundamental rethinking of business processes that helps achieve dramatic improvements in performance [5] [9] [10]. Electronic commerce (on vendors' side) and electronic procurement (on buyers' side) offer the opportunity to redesign business processes. El Sawy [7] has provided eleven principles that can be used as guidelines for BPR efforts in the context of World Wide Web-based electronic commerce. The eleven principles can be grouped in four categories: the first one focuses on streamlining a business process and removing valueless activities, the second on restructuring it to allow for a faster and a flexible execution of that process, the third on capturing, "moving" and generating information around a process, and the fourth on creating and managing knowledge around a process. Commercial websites typically include electronic catalogs, shopping carts, payment systems and order tracking systems that can support the redesign of vendors' order fulfillment and/or buyers' procurement processes through the implementation of the BPR principles related to the first three categories presented above. Other systems can be developed to build repositories and further analyze data, allowing for the management of knowledge around the

transactions commercial websites can support.

The objective of this paper is to analyze how functionalities of commercial websites deployed by vendors are used in the context of electronic procurement and how such usage affects operations of both buyers and vendors. Such investigation is based on a Data Envelopment Analysis (DEA) model that identifies the minimum functionalities that create the maximum value for buyers. The rest of the paper is organized as follows. Section 2 presents the basics of DEA, Section 3 the research model and Section 4 the methodology. Findings are presented in Section 5. The discussion and the implications of this research conclude this paper.

II. DEA Basics

DEA is used to establish a best practice group amongst a set of observed units and to identify the units that are inefficient when compared to the best practice group. DEA also indicates the magnitude of the inefficiencies and improvements possible for the inefficient units. Consider n Decision Making Units (DMUs) to be evaluated, DMU_j ($j=1,2,\dots,n$) that consumes the amounts $X_j = \{x_{ij}\}$ of m different of inputs ($i=1, 2, \dots, m$) and produces the amounts $Y_j = \{y_{rj}\}$ of r outputs ($r=1, \dots, s$). The input oriented efficiency of a particular DMU_0 under the assumption of variable returns to scale (VRS) can be obtained from the following linear programs (input-oriented VRS mode):

$$\begin{aligned} \min_{\theta, \lambda, s^+, s^-} \quad & z_0 = \theta - \varepsilon \cdot \bar{1}s^+ - \varepsilon \cdot \bar{1}s^- \quad (1) \\ \text{s.t.} \quad & Y\lambda - s^+ = Y_0 \\ & \theta X_0 - X\lambda - s^- = 0 \\ & \bar{1}\lambda = 1 \\ & \lambda, s^+, s^- \geq 0 \end{aligned}$$

where s^+ and s^- are the slacks in the system.

Performing a DEA analysis requires the solution of n linear programming problems of the above form, one for each DMU. The optimal value of the variable θ indicates the proportional reduction of all inputs for DMU_0 that will move it onto the frontier which is the envelopment surface defined by the efficient DMUs in the sample. A DMU is termed efficient if and only if the optimal value θ^* is equal to 1 and all the slack variables are zero. This model allows variable returns to scale. The dual program of the above formulation is illustrated by:

$$\begin{aligned} \max_{\mu, v} \quad & w_0 = \mu^T Y_0 + u_0 \quad (2) \\ \text{s.t.} \quad & v^T X_0 = 1 \\ & \mu^T Y - v^T X + u_0 \bar{1} \leq 0 \\ & -\mu^T \leq -\varepsilon \cdot \bar{1} \\ & -v^T \leq -\varepsilon \cdot \bar{1} \\ & u_0 \text{ free} \end{aligned}$$

If the convexity constraint ($\bar{1}\lambda = 1$) in (1) and the variable u_0 in (2) are removed, the feasible region is enlarged, which results in the reduction in the number of efficient DMUs, and all DMUs are operating at constant returns to scale (CRS). The resulting model is referred to as the CRS model.

In summary, each DEA model seeks to determine which of the n DMUs define an envelopment surface that represents best practice, referred to as the empirical production function or the efficient frontier. Units that lie on the surface are deemed efficient in DEA while those units that do not, are termed inefficient. DEA provides a comprehensive analysis of relative efficiencies for multiple input-multiple output situations by evaluating each DMU and measuring its performance relative to an envelopment surface composed of other DMUs. Those DMUs forming the efficient reference set are known as the peer group for the inefficient units. As the inefficient units are projected onto the envelopment surface, the efficient units closest to the projection and whose linear combination comprises this virtual unit form the peer group for that particular DMU. The targets defined by the efficient projections give an indication of how this DMU can improve to be efficient.

III. Research Model

From vendors' perspective, the cost of developing and maintaining commercial websites increases as features supporting the selection and the transactional (i.e., the execution and the tracking) phases of the procurement process are added to informational websites [17] [19]. This research analyzes how functionalities of commercial websites are used to support the procurement process and to link them to benefits buyers report. A DEA model using websites' functionalities as inputs and websites' usefulness, reduced search costs and reduced processing costs as outputs was created accordingly. The proposed model can provide vendors with guidelines on how to design efficient commercial websites based on ratings from buyers who use them to carry out their procurement tasks. In this context, the proposed DEA model can minimize the functionalities (and therefore the cost) of commercial websites and maximize the benefits as perceived by buyers.

Figure 1 presents the model used for this research. The inputs and outputs were measured from the perspective of buyers using the deployed commercial websites. A survey of corporate buyers helped collect data related to the

functionalities and the benefits of the general commercial websites they interact with when carrying out their procurement tasks. From this perspective, each rating related to the functionalities and benefits of commercial websites respondents generally access is considered as a DMU.

FIGURE 1 HERE

Input orientation was selected for the DEA model in this research as vendors deploying commercial websites would be more interested in minimizing the cost subject to attaining the desired output levels. Both types of envelopment surfaces, BCC and CCR will be used and scale efficiency issues will be examined.

IV. Methodology

To collect data used in this research, a questionnaire was sent to all the 988 corporate buyers members of the "Corporation des Approvisionneurs" in the province of Quebec, an organization affiliated to the Purchasing Management Association of Canada. Respondents were surveyed about their general perspectives regarding the functionalities and the usefulness of the commercial websites they generally access to carry out their procurement tasks. Respondents were also surveyed about the perceived performance improvements related to such usage. Among the 114 corporate buyers who returned a usable questionnaire, 88 reported accessing commercial websites to carry out their procurement tasks. The sample spanned corporate buyers working for over 80 different organizations doing business in a wide range of industries.

Seven-point Likert (1=Strongly disagree, 7= Strongly agree) scales were used to measure the inputs (or functionalities of commercial websites) and outputs (i.e., usefulness of commercial websites, reduced search costs and reduced processing costs) of the DEA model. Whenever possible, pre-existing instruments were used because normally they have been tested for reliability and validity properties: the measure of the functionalities was based on Leenders et al. [13]; usefulness was measured using a four item-scale by Karahanna et al. [12]; the assessment of reduced search costs was based on Bakos [2] and Barua et al. [3] whereas the measurement of reduced processing costs was based on Jones and Beatty [11].

After the survey, the validity of the instrument was assessed using a factor analysis. The well-known criterion of eigenvalue greater than one was applied. A factor loading greater than .50 with the theoretically correct sign was required for the assignment of an item to a factor. The principal components method with Varimax rotation was used to extract the factors. The reliability of the instrument was assessed using the Cronbach's alpha. Findings from the factor analysis show support for the validity of the scale. The Cronbach's alpha varied from .67 to .93 showing acceptable level of reliability of the scales. No item significantly deflated alpha, so all items were kept for

analysis. The score for each of the five factors retained equaled the mean score of its retained items and was used as inputs and output scores in the model. Table 1 summarizes the validity and the reliability analyses performed is presented.

TABLE 1 HERE

V. Findings

Descriptive statistics based on a seven-point scale show that respondents use commercial websites to support to a greater extent their identification (Mean = 6.1) and their selection (Mean = 4.1) tasks and to a lesser extent their execution (Mean = 2.5) and their post-sale tasks (Mean = 3.4). Furthermore, respondents consider accessing commercial websites to be useful (Mean = 5.3) for the procurement process and report on average a greater improvement in search costs (Mean = 5.3) than in processing costs (Mean = 3.3).

DEA findings are first used to analyze the link between the functionalities commonly used and the benefits for buyers. The DEA results summarized in Table 2 show that the model identifies 92% technical efficiency. Scale efficiency can be calculated as the ratio of the CCR and BCC scores. If the frontiers of the CCR and the BCC models are very close, one can conclude that the DMUs operate at constant returns to scale. Otherwise, there is significant scale inefficiency. Comparison of the BCC scores with CCR scores shows that most of the units are operating under constant returns to scale since the scale efficiency is very close to 1. Thus, the CCR efficiency score will be used in the following analysis unless otherwise stated.

TABLE 2 HERE

It is observed that most of the ratings are efficient; however, results show that buyers can use a reduced number of functionalities without reducing the level of benefits they report.

DEA results are further used to analyze the effect of different functionalities on the efficiency of users' ratings. The DEA model divided the data set into efficient and inefficient groups. Table 3 presents the average rating on each functionality for the efficient and the inefficient group. Findings show that the two groups have different input mixes and that the inefficient group of ratings reports a higher level of usage of the functionalities that support the execution and the post-sale activities. This indicates that reducing the level of access to these functionalities can lead to a greater efficiency in ratings. Results show however that a higher level of usage of functionalities that support the identification and selection activities is critical for the benefits reported. Results from Mann-Whitney tests at the confidence level of .95 confirmed the significant differences in functionalities usage between the two groups of ratings.

TABLE 3 HERE

Overall, findings suggest that the identification and selection functionalities are the most important factors affecting the benefits buyers get from accessing commercial websites to carry out their procurement tasks. Further analyses examined the non-response bias and the possible confounding factors. Findings showed support for the representativeness of the sample and for the independence between respondents' profile and DMUs' efficiency.

VI. Discussion and Implications

Findings from this study suggest that buyers logging onto commercial websites to carry out their procurement tasks tend to use them essentially for the identification and the selection of suppliers. They suggest also that more advanced functionalities of commercial websites such as the online ordering system, the online payment systems or the online tracking system does not add much benefit as perceived by users of such systems. As a result, buyers accessing vendors' websites tend to report more important reductions in search costs than in processing costs.

Possible explanations as to why using the transactional functionalities of commercial websites present less interest for corporate buyers include the perceived lack of security regarding web-based transactions and a personal preference for more traditional ways (phone calls, on-site visits, paper-based) to do business with suppliers.

Findings from this study have implications for both vendors deploying commercial websites and buyers using them. Vendors who are interested in new channels to sell their products and services must balance their business strategy and operations between "pure play" electronic commerce and "brick and mortar". The "bricks and clicks" in the middle of such continuum requires that vendors provide both channels and synchronize the "physical" and the "digital" business processes [1] [7]. However, findings from this research suggest that vendors may experience a somewhat reduced volume of transactions executed through their websites, hence limiting the effect online order fulfillment systems can have on the redesign of front-office operations and their integration to back-office operations. From the perspective of El Sawy's [7] set of BPR principles, informational websites and electronic catalogs only help implement two of the eleven principles identified (namely streamlining and losing wait) allowing for a limited streamlining and a very limited restructuring of front-office operations but not allowing for any management of the information and of the knowledge around such processes. Moreover, vendors concerned with balancing the cost of developing and maintaining their companies' commercial websites and the benefits of such systems as perceived by potential buyers can opt for websites that just support the identification and the selection phase of the procurement

process. Such websites may offer the maximum usefulness given their limited functionalities and therefore, given the costs they involve.

The implication of our findings on buyers' side is that, although commercial websites have the potential to support the entire procurement process, they are essentially used to establish communication channels with suppliers. In this context, commercial websites help reduce the time and effort (the so-called search costs) needed to identify and select a supplier for a given transaction. Findings from this study show however that commercial websites are rarely used to order inputs, pay for them or to check the status of such orders. Corporate buyers tend to opt for other means (probably more traditional means) to execute their transactions, which limits any improvement in processing costs and any dramatic redesign of the procurement process.

The objective of this research was to investigate the range (and the extent to which each) of functionalities of commercial websites buyers use to support the procurement process. The implications of our findings on related business operations and on the design of such websites were discussed. Future research can investigate such relationships for specific commercial websites in specific industries. Future work should measure the inputs from the perspective of organizations that deploy commercial websites and take into account several outputs related to the benefits of commercial websites' functionalities for organizations that implement them and for customers who use them.

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Table 2. DEA Results

	BCC	CCR
Technically Efficient		
Average Score	0.92	-
Standard Deviation	0.11	-
Technically & Scale Efficient		
Average Score	-	0.85
Standard Deviation	-	0.16
Maximum Efficiency Score	1	1
Minimum Efficiency Score	0.63	0.15
Scale efficiency	0.924	

Table 3. Average input scores for efficient and inefficient commercial websites

	Efficient group (N = 32)	Inefficient group (N=56)	Asymp. Sig. (2-tailed)
Identification	6.06	6.15	0.936
Selection	3.84	4.34	0.151
Execution	1.63	3.08	0.000
Post-sale support	2.53	3.95	0.001

Why Do People Share Music Files in the P2P Environment: An Ethical Decision Perspective

Rong-An Shang, Yu-Chen Chen, Pin-Cheng Chen

Department of Business Administration

Soochow University

No 56, Section 1, Kuei Yang Street, Taipei, Taiwan, 100, ROC

E-mail: rashang@scu.edu.tw, cyc@scu.edu.tw, pandean@ms45.url.com.tw

Abstract: Digitalized information and the Internet have brought great impacts on the music and movies industries. This study tested the ethical decision model of Hunt-Vitell to understand why and how people share unauthorized music files with others in the P2P network. Four scenarios of using P2P system and four norms related to them were proposed in the study. The results indicate that the deontological norm of anti-piracy, whether is theft of intellectual property or not, is not the main factors affecting P2P users' ethical consideration regarding sharing music with others. The results also suggest the music companies should care more about how to realize the benefits of the digital and network technology to increase the consumers' welfare instead of just declare the intellectual property they owned and resist the innovations caused by the new technologies.

Keywords: P2P computing in e commerce, Ethical Decision Model, Computer Ethics, Music industry, Consumer ethics

I. Introduction

Information technology has changed the economics of production and distribution of information products. Because the cost of reproduce a copy of digitalized information is low and the quality of the copies is almost the same as the original one, piracy has been recognized as a major ethical issue in the information age (Mason, 1986). Most of the previous studies of piracy focused on the unauthorized software copying or soft-lifting of students or IT professions. Probably due to that most people perceive softlifting causing little harms to the faceless, billion-dollar company, software piracy may not be perceived as an unethical behavior (Logsdon et al., 1994). Researchers suggest introducing ethical consideration and code of conduct in the education as solutions for the problem. However, there are still arguments for and against unauthorized copying of software (Siponen and Vartianine, 2004).

The technologies of peer-to-peer (P2P) architectures, in which users directly connect to the others to share and download files, further speeds up the propagation of digital resources. Although, under the present laws, act of exchanging copyrighted file is probably an invasion of

intellectual property (Lessig, 2002; Von Lohmann, 2003), people still now exchange a huge amount of digital music or movie in the P2P network. File sharing using P2P networks has been called the "killer application" in the Internet (Krishnan et al., 2003), or the disruptive innovation for the music industry (Spitz and Hunter, 2003). The norms of using the P2P network are still emerging (Spitz and Hunter, 2003), and thus it raises the needs for understanding people's ethical perception of sharing copyrighted files in the P2P network. The users' motives and concerns for downloading or sharing music files in the P2P environment are not the same as the motives and concerns for softlifting. Factors affecting ethical decisions of people in the P2P environment are still unclear.

User's unauthorized copy of music files is a problem of consumer ethics. Previous studies of consumer ethics often use Hunt and Vitell's (1986) model to describe the ethical decision making processes of consumers (Vitell, 2003; Vitell et al., 2001). This model has also been shown useful for understanding the decision processes of softlifting (Tong and Yap, 1998). However, people using P2P network may face dilemmas caused by the conflicts among different norms. This fact was rarely investigated by previous studies. This study proposed and tested a simplified model derived from Hunt-Vitell's model to describe people's ethical decision processes about sharing unauthorized music files in the P2P network. We also extended Hunt-Vitell's model to test and investigate the impacts of the beliefs of the norm of anti-piracy, the ideology of free software, the norm of reciprocity, and the ideology of consumer right on the deontological evaluation of sharing music files in the P2P environment.

II. Theoretical Background

The Hunt-Vitell model is grounded on the deontological and teleological theories of moral philosophy to describe the decision-making process for situations involving a marketing ethical problem (Hunt and Vitell, 1986). Deontological theories focus on the specific actions or behaviors of an individual while teleological theories focus on the consequences of those actions. The model suggests the ethical decision-making process is initiated by the individual's perception of an ethical problem in a situation, and then the perception of various possible alternatives that might be used to solve the problem. The ethical judgments in this situation are determined by both the deontological and teleological evaluation of the subject. The former

involves a comparison of the various alternatives with a set of predetermined deontological norms that represent the individual's personal values. Teleological evaluation is a function of the perceived consequences of each alternative for various stakeholders, the probability that each consequence will occur to each stakeholder group, the desirability of each consequence, and the importance of each stakeholder.

The model proposes that ethical judgments impact people's behavior through the mediation of their intention. However, moral intention will differ from ethical judgments because the teleological evaluation also independently affects moral intention. Behavior will also differ from moral intention resulted from the situational constraints. The model also suggests cultural, industrial, and organizational environment, and personal experiences as four external constructs that affect the ethical decision processes. After the conduct of behavior, an evaluation of the actual consequences of the chosen alternative will affect an individual's experience, forming an iterative loop of learning in the model.

For the Hunt-Vitell model presents the various philosophical theories that explain a decision maker's ethical judgments and the details of the individual decision-making process, it is widely used in the researches of ethical decision making in marketing (Vitell and Ho, 1997). Vitell et al. (2001) and Vitell (2003) have also suggested that by eliminating the constructs of professional, organizational and industrial environments, the Hunt-Vitell model is the most appropriate model for testing the research questions involving consumer ethics. Consumers' copying or buying unauthorized software is also a major issue in consumer ethics. Previous researches have shown the Hunt-Vitell model can adequately describe the ethical decision-making process involving software piracy (Thong and Yap, 1998). However, researches also found that, probably due to that most people perceive softlifting as causing not much harms to anyone, and the "victims", i.e., the individual software developers or companies, are perceived as far removed from and impersonal to the softlifters (Logsdon et al., 1994; Simpson et al., 1994, Vitell et al., 2001), unauthorized copying of intellectual properties such as software, tapes or movies was not perceived as even being unethical at all (Vitell, 2003).

III. Research Framework

Because the Hunt-Vitell model is complex, empirical studies usually simplify and test only part of the model (Vitell and Ho, 1997). The deontological norms in the model could range from general beliefs about such things as honesty, stealing, cheating and treating people fairly to issue-specific beliefs about such things as deceptive advertising, product safety, sales "kickbacks," confidentiality of data respondent anonymity and interviewer dishonesty (Hunt and Vitell, 1986). However, prior studies usually simplify the model by including only one set of deontological norms as the

determinant of deontological evaluation. For examples, studies about the information system ethics could use the professional code of conduct such as the ACM as the deontological norms (Thong and Yap, 1998). Therefore, the ethical dilemmas of the conflicts among different norms were not shown in the previous studies, and it implicates the dilemmas of the ethical decision in these studies were primarily caused by the conflict between the deontological evaluation and the teleological one.

But people using a P2P system to share music files with others may face the dilemmas caused by the different norms (Spitz and Hunter, 2003). Siponen and Vartiainen (2004) proposed several approaches for and against the unauthorized copying of software and shows that there are still arguments about this issue. Because most of the music files shared in the P2P networks are copyrighted, sharing them with, or providing them to or even downloading files from others in the P2P network, is very likely a piracy and against the law of intellectual property right (Von Lohmann, 2003). Therefore, for the using of the P2P network to share copyrighted music files with the others, we propose that:

H1 : Deontological Evaluation is negatively related to the subject's belief in the norm of anti-piracy.

On the other hand, there are also some arguments for the sharing of music files in the P2P network. First, the culture of freeware ideology is popular among users of Internet in its early age. Stallman (1995) argues for the importance of freeware in the information age and indicates that enforcing copyright is harming society as a whole. Raymmod (2000) further promotes the open source software and suggests the social status in the age of abundance is determined not by what you control but by what you give away. Gift giving is a way of creating and maintaining relationships of power, and then transforms these relationships to interdependencies based on the idea of reputation (Bergquist and Ljungberg, 2001). The spread of the open source software companies that earn profits by providing services has suggested the feasibility of the open source business model. Information technology should bring the similar revolutionary change in the music industry as well. Instead of selling the compact discs of the music, the musicians and the music companies can earn profits by providing the service of performance and the complementary products based on the reputations they earned (Liebowitz, 2002). Therefore, we define the belief that digital information should be free in the Internet era to maximize the social benefits as the ideology of freeware and propose that:

H2 : Deontological Evaluation is positively related to the subject's belief in the ideology of freeware.

The success of the P2P network lies in its users' being willing to share files with the others. Resources in the P2P environment are analogous to the public goods, and the problem of "free-riding" might prohibit users' intention to share resources with others (Asvanund et al., 2004; Krishnan et al., 2004; Shneidman & Parkes, 2003). The social

exchange theory suggests the norm of reciprocity is probably the prerequisite for users in a P2P network to emerge into a cooperative community to solve the free-riding problem. Blau (1964) stated that the starting mechanism of social interaction and group structure is the need to reciprocate for benefits received in order to keep receiving them. The participant in a P2P network is motivated to contribute valuable resources to the community because of a pre-existing expectation that he/she will receive something

useful in return (Tiwana & Bush, 2000). Nissenbaum (1995) also justifies user's copying software as an act of generosity or kindness to satisfy the need of his/her friend. Providing files to the community may be perceived as necessary and ethical for members in the P2P community. Therefore, we proposed that:

H3 : *Deontological Evaluation is positively related to the subject's belief in the norm of reciprocity.*

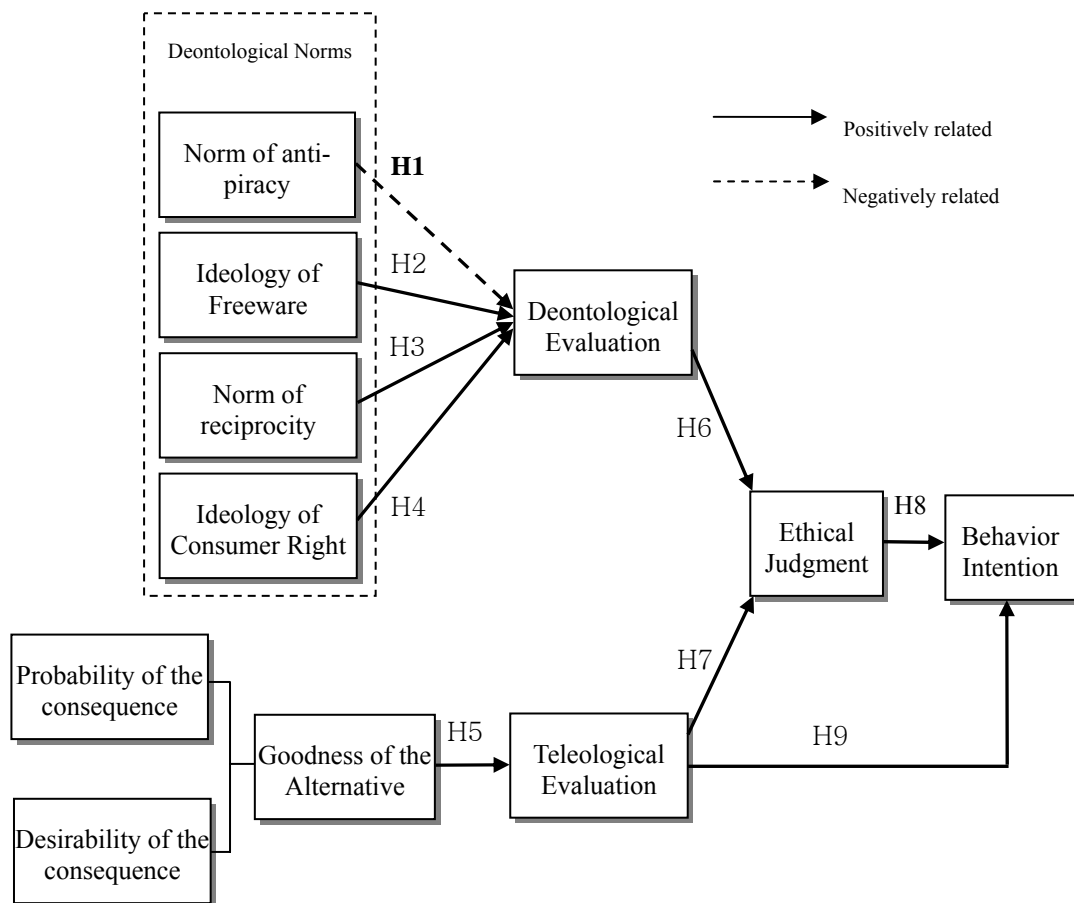


Figure I Research framework

The big music companies today may have earned extra revenue from their nearly oligopoly control of the distribution channel of music. As file sharing using P2P networks has been perceived as the disruptive innovation to the music industry (Krishnan et al., 2003; Spitz and Hunter, 2003), the new technology will change the distribution channel of music, the structure of the music industry, and even the distribution of revenues of this industry (Clemons

et al., 2002). Consumers can access to the music they like in the Internet instead of buying music CD under the control of the music companies. For example, consumers should have the right to buy just the music they like, instead of having to buy twelve music songs or so bundled in a CD. The musicians can also earn more without the control of the music companies. Besides, because the music is experienced goods, consumers may have to have listened to the music before they can make the decision to buy it. As a result, the distribution of music files in the P2P network may attract

more people to access to and then buy the music (Spitz and Hunter, 2003). The big music companies may, through their oligopoly power, try to defer the diffusion of the new technologies and the emergence of an innovative business model, and hurt the benefits of consumers and even musicians. We defined the ideology of consumer right as a belief about the basic requirements of consumers that have to be satisfied in a fair transaction, and we proposed the hypothesis that:

H4 : *Deontological Evaluation is positively related to the subject's belief in the ideology of consumer right.*

Previous studies usually simplify the teleological evaluation process in the empirical test of the Hunt-Vitell model. We also simplified the determinants of teleological evaluation by dropping the importance of stakeholders and incorporated the evaluation of stakeholders into the other components. We defined the perceived goodness of an alternative as the summation of the multiplications of the probability of the consequence and the desirability of the consequence for each possible consequences of the alternative. Therefore, we proposed that:

H5 : *Teleological evaluation is positively related to the subject's perceived goodness of the alternative.*

Finally, the Hunt-Vitell model suggests four core hypotheses that ethical judgment is determined by both the deontological evaluation and teleological evaluation, and moral intention of the behavior is determined by the ethical judgment and teleological evaluation. The hypotheses and research model of this study is shown in figure 1, and these four hypotheses are listed as followed:

H6 : *Ethical judgment is positively related to the deontological evaluation.*

H7 : *Ethical judgment is positively related to the teleological evaluation.*

H8 : *Behavioral intention is positively related to the ethical judgment.*

H9 : *Behavioral intention is positively related to the teleological evaluation.*

IV. Research Method

The research model was tested by a scenario survey as suggested by Hunt and Vitell (1986). Because using P2P system to share music files with others is popular among teenagers, High school and university students were selected as the subjects for the study. The design of the scenario questionnaire is similar to the one used in the previous study (Thong and Yap, 1998). To evaluate whether or not the scenario and the items are understandable to the specified subjects, and the appropriateness of the alternatives and consequences, a pretest was conducted on 34 first-year

junior high school students. Some items and consequences of alternatives were revised according to the interviews with the subjects. Then, a pilot-study was conducted with a convenient sample of 73 junior high school students to evaluate the validity and reliability of the measurements. 62 valid responses were acquired and the measurements of the ideology of freeware and the ideology of consumer right were revised to increase the validity and reliability. The design of the finalized questionnaire was as followed:

Deontological norms. The questionnaire begins with the items measure the four deontological norms. Norms of anti-piracy were measured by six items revised from the items used to measure the deontological norms related to softlifting in Thong and Yap (1998). Some items were revised because these items were used to measure the piracy of music instead of software. Scales to measure the ideology of freeware, norm of reciprocity, and the ideology of consumer right were developed in this study by asking the subject if he/she agree with statements related to the norms. All the items mentioned above were measured on a seven-point Likert-type scale. Items measure deontological norms are listed in the appendix A.

Scenario. After the items measuring the deontological norms, paragraphs illustrated the details of a popular mode of P2P system were presented. The scenario describe a system of monthly pay of NT\$99 to search for and download files from the other users on this system. Once upon a user installs the software, the system will automatically build a shared folder in his/her hard disk. Files downloaded from the other users will be saved in this shared folder. While connecting to the system, a list of the files stored in this shared folder will be sent automatically to the server, and the other users in the network will be allowed to download files from this shared folder. There is a huge number of music files on the system now.

Alternatives. We presented four alternatives for the scenario. First of all, because users may concern about the legal issue of providing copyrighted files to the others in the Internet, they may just download files they like from the network but will not provide files to others. Secondly, some users may feel dutiful to provide the downloaded files to others under the norm of reciprocity, so will keep the downloaded files in the shared folder. Thirdly, except for the second kind of behavior, it is curious that where the original copy of the music files came from. Probably caused by the ideology of freeware on the Internet, some users may copy the music files from elsewhere, or even convert the music from the other format, into the P2P network. Finally, if the users don't care about the piracy, it would be strange why they would pay for using the P2P system. Therefore, we proposed some users might try to use the other free P2P systems or use other people's account such that they don't have to pay for it. As we intended to compare the impacts among different norms, the alternative of not using the system was not included in the study. The alternatives in this study is listed below:

Alternative 1. *I would pay to use the P2P software to download the music files from the others, but I would move the file from the shared folder once it is downloaded.*

Alternative 2. *I would pay to use the P2P software to download the music files from the others, and I would keep the downloaded files in the shared folder so the others could download the files from my computer.*

Alternative 3. *I would pay to use the P2P software to download the music files from the others and keep the downloaded files in the shared folder. Besides, I would also copy the other music files I have into the shared folder to let the others download these files from my computer.*

Alternative 4. *I would use the other free P2P system to share music files with the others.*

Deontological Evaluation. As in the previous study (Thong and Yap, 1998), deontological evaluations of each alternative were measured by two 7-point Likert scales that asking the subjects if they agree that “Based on my own values, without considering any possible consequences, I think Alternative (1) is very ethical,” and “Based ..., I think Alternative (1) is ethically acceptable.”

Consequences. The positive and negative consequences to the stakeholders, including the user him/herself, the music company, the artists, and the other users in the P2P system, under each alternative were identified. Consequence of each alternative were listed in the appendix B. We first measured the subjects’ evaluation of the probability of the consequences for each alternative by asking them to identify the probability on a 11-point scale, from the probability equals to 0 to the probability to 1, 0.1 per interval. After that, we asked the subjects to evaluate how much they desire for each consequence, from very dislike to very like on a 7-point scale.

Teleological Evaluation and Ethical Judgment. The measurement of teleological evaluation and ethical judgment were also followed the study of Thong and Yap (1998) by

asking “Based on the possible consequences, I think that Alternative (1) is very ethical,” and “Based ..., I think that Alternative (1) is ethically acceptable” for teleological evaluation, and “Considering both the possible consequences and my own values, I think that Alternative (1) is very ethical,” and “Considering ..., I think that Alternative (1) is ethically acceptable” for ethical judgment. All the measures were in a 7-point Likert scale.

Behavior Intention. Behavior intention of each alternative was also measured on a 7-point Likert scale that asking “In the above scenario, Alternative (1) would definitely not be the alternative I would choose,” as was used in Thong and Yap (1998). Finally, we asked the subjects if they feel hard to make decision in the situation, also on a 7-point Likert scale, to measure if the subject perceived he/she were in an ethical dilemma situation.

The actual surveys were conducted in the class of a convenient sample of high school and college students. The subjects were asked to follow the sequences of the questionnaire to answer the questions. Although the subjects were told it’s all right if they don’t want to take part in the study, they still may not be truly voluntary. Therefore, we used an item in the desirability of consequences as a criterion for the valid sample. Respondents with the answer that they would like to be sued for the piracy were judged as invalid. Totally 674 questionnaire were submitted and excluding the incomplete and invalid ones, 453 valid samples were acquired. 253 respondents among the sample had used a P2P system before. 163, 101, and 189 samples were respectively senior high school, junior high school, and university students.

V. Results

Table 1 shows the results of the deontological evaluation, teleological evaluation, ethical judgment, and behavior intention of each alternative.

Table 1. Descriptions of the results

	Mid ^a	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
		Mean	SD ^b	Mean	SD	Mean	SD	Mean	SD
Deontological evaluation	8	9.07	3.16	9.00	2.95	8.66	3.08	8.85	3.33
Teleological evaluation	8	8.54	2.96	8.55	2.66	8.36	2.87	8.43	3.11
Ethical judgment	8	8.60	2.98	8.55	2.67	8.30	2.87	8.29	3.05
Behavior intention	4	4.29	1.65	4.31	1.60	4.27	1.44	4.28	1.46

^a: Mid value of the scale.

^b: Standard deviation

All of the means of these variables were a little higher than the middle value of the scale, suggests the subjects may present a neutral but somewhat positive attitude toward these alternatives. Table 1 also shows there were no significant differences of these variables among alternatives.

A principal components analysis with orthogonal rotation by varimax method was conducted to test the construct validity. Table 2 presents the factor structure for the variables of deontological norms. Four factors with eigenvalues larger than one were extracted and the result

shows the data fit well with the predicted factor structure. Table 2 also shows all the Cronbach’s α of the four deontological norms were larger than 0.7, suggests the reliability of these variables were acceptable. Table 3 presents the Cronbach’s α of the three variables in the ethical decision processes of each alternative. The results also indicate good reliabilities of these variables.

We used the structure equation modeling with observed variables to test the path structure in this research. Item scores of each construct were summarized to calculate the

observed score of the variable. Table 4 shows the results of the path analysis and hypothesis testing for each alternative. The ideology of consumer right had a significantly positive effect on deontological evaluation of all the alternatives. Hypothesis 4 was supported in this study. On the other hands, the norm of reciprocity didn't influence the deontological evaluation of any alternative. Hypothesis 3 was not supported. People interact with each other to exchange resources in the P2P network. Although there are usually some forums functioned as the space of interaction for the P2P systems (Spitz and Hunter, 2003), the anonymity of computer-mediated-communication may reduce the impacts of the norms of P2P community because the anonymity would decrease the social presence (Short et al., 1976), or reduce the social cues conveyed in the social interaction (Kiesler et al., 1984; Rutter, 1984).

The impacts of the norm of anti-piracy and the ideology of freeware were different among alternatives. The ideology of freeware significantly affected the deontological evaluation in alternative 3. This result suggests the ideology of freeware could explain where the original copy of the files came from and why there was some people copying files from elsewhere or transferring files from the other format. The ideology of freeware also affected the deontological evaluation in alternative 4, indicates that people with the ideology of freeware would try to use a free P2P system. However, it is interesting to note that the norm of anti-piracy affected deontological evaluation only in the alternative 4. In other words, people who had paid for using the system seem to care less about the piracy issue. This is probably due to that they suppose that, since they have paid for the benefits they get, piracy is only a problem between the P2P and the music companies. This may explain why although there are some free or opensource P2P systems, the systems with charge are still popular among users.

The hypothesis 5, 6, and 7 were all supported in the study. The subject's perceived goodness of the alternative measured by the proposed had a significantly positive influence on the teleological evaluation. The ethical judgment was affected both by the deontological and teleological evaluation. However, the impacts of the teleological evaluation were larger than the impacts of the deontological evaluation in all of the four alternatives. Finally, this study found that the subjects' intention to download files but not provide files to the others, and the intention to use free P2P systems were primarily influenced by the teleological evaluation but not the ethical judgment. On the other hand, the subjects' intention to provide the files they downloaded from the P2P network to the others was influenced by the ethical judgment, and the intention to look for or transfer files from elsewhere was influenced by both the ethical judgment and teleological evaluation.

VI. Conclusion

Copying and distribution of digital files in the Internet have brought great threats to the music industry. This study tested

the Hunt-Vitell model to understand users' ethical decision about copying unauthorized music files in the P2P network. The results show that the deontological evaluations are influenced by the ideology of consumer right for all alternatives, and by the ideology of freeware and the norms of anti-piracy for some alternatives, but are not affected by the norms of reciprocity. However, results of this study should be explained carefully. The Hunt-Vitell model does not describe well the way that people in the real world make ethical judgments (Cole et al., 2000). The model suggests that when behavior and intentions are inconsistent with ethical judgments, one of the consequences will be the feel of guilt (Hunt and Vitell, 1986).

But the work of Strutton et al. (1994) indicates that even normally ethical consumers can easily rationalize unethical behaviors by appealing to the techniques of neutralization (Vitell, 2003). The impacts of the deontological norms found in the study may be just the rationalized attribution after the decision has been made, instead of the factors affect the decision processes.

The above findings have implications for the music companies. Since consumers can easily rationalize their behavior by the norms such as the ideology of consumer and the ideology of freeware to reduce the feeling of guilt while copying files from the Internet, just proclaim the intellectual property rights and the norm of anti-piracy would be of little use for diminishing the unauthorized copying. Besides, the study found that people might not concern about the piracy issue when they have paid for using the P2P system. The popularity of the charging P2P system may suggest that people would like to pay something to reduce their guilty feeling about copying files. The success of iTunes may firmly support the above idea. Therefore, companies should try their best to apply and realize the benefits of the new technology to increase their consumers' welfare, instead of waiting and resisting the change and just declaring their rights and imposing the quilt of piracy upon their customers. Consumers may be more willing to respect the intellectual property rights of the companies if these companies make every endeavor to increase their consumers' benefits.

VII. Appendix

The appendixes are not included because of the limits of space. The appendixes are available upon request to the first author.

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Table 2. Factor structure for deontological norms

	Component				α
	1	2	3	4 ^a	
Anti-piracy1	.67				.81
Anti-piracy2	.72				
Anti-piracy3	.72				
Anti-piracy4	.69				
Anti-piracy5	.76				
Anti-piracy6	.67				
Freeware7	^b		.54		.80
Freeware8			.76		
Freeware9			.71		
Freeware10			.68		
Freeware11			.60		
Freeware12			.65		
Freeware13			.55		.72
Reciprocity14				.68	
Reciprocity15			-	.79	
Reciprocity16			-	.76	
Consumer-right17		.60			.83
Consumer-right18		.66			
Consumer-right19		.75			
Consumer-right120		.82			
Consumer-right21		.61			
Consumer-right22		.74			

^a: Cumulative explained variance: 54.39%^b: Suppress absolute values < 0.4**Table 3. Cronbach's α s for the constructs**

Constructs	Alternative			
	1	2	3	4
Deontological evaluation	.82	.88	.87	.90
Teleological evaluation	.77	.78	.82	.82
Ethical judgment	.81	.82	.83	.83

Table 4. Summary of the hypothesis tests

Hypothesis	Alternative			
	1	2	3	4
H1	.08 ^a	-.04	-.06	-.12**
H2	.02	.08	.10*	.19**
H3	.07	.06	.04	.04
H4	.22**	.32**	.30**	.23*
H5	.15**	.34**	.40**	.39**
H6	.14**	.13**	.09**	.10**
H7	.75**	.77**	.82**	.79**
H8	.10	.32**	.16*	.12
H9	.24**	.12	.18*	.33**

^a Standardized coefficient** $p < 0.01$; * $p < 0.05$

Small Tourism Accommodation Distribution Patterns in Canada

David Gilbert *, Simon Hudson **

* Professor of Marketing, School of Management, University of Surrey
Guildford, Surrey, GU2 7XH.

Tel: +44 (0) 1483 683981, Email: D.Gilbert@surrey.ac.uk

** Associate Professor, Haskayne School of Business, University of Calgary,
2500 University Drive NW, Calgary, Alberta, Canada, T2N 1N4.

Tel: +1 (403) 220 8738 Fax: (403) 282 0095, Email: simon.hudson@haskayne.ucalgary.ca

Abstract: A review of the previous research on small businesses in tourism and hospitality shows a growing interest in Internet marketing. However, the research that exists is contradictory. On the one hand, some researchers suggest that because the entry barriers are low, it is cost effective for small businesses to set up an Internet presence, which helps level the playing field between small and large firms [18]; [21]. However, other researchers indicate that e-commerce is not being adopted as readily by small tourism and hospitality businesses as one might have expected [17]; [6]; [31]. Clearly, more research is required in this area regarding Internet usage in small tourism and hospitality businesses. This study will therefore examine small businesses (less than 50 employees) – specifically Bed and Breakfasts (B&Bs) - to develop theories identifying factors that facilitate and inhibit the adoption and implementation of Internet technology in the accommodation sector.

Keywords: Internet, marketing, small businesses, online surveys.

I. Small Businesses and the Internet

The majority of research addressing issues of Internet technology has focused on the motivating factors behind developing an online presence rather than the barriers to adoption. Many studies have shown that low development and maintenance costs play a critical role in the decision to go online [18]; [10].

Research has also shown that many tourism and hospitality businesses, especially in the accommodation sector, can overcome the disadvantages of small size through their use of the Internet to grow by reaching consumers beyond their borders [18]; [17]; [13]. [22] explain that while a firm may not have an explicit international expansion strategy, the Web site automatically positions the firm in the international marketplace. Similarly, [12] suggest that the Internet can be a very powerful tool to assist small firms in overcoming the main barriers to internationalization and allow gradual change. [20] argues that the use of the Internet as a marketing platform offers small specialist firms in tourism considerable prospects to both reach and to cover traditional and emerging tourism markets. Others have suggested that the Internet can be a

powerful tool for delivering information [17], attracting affluent customers and relationship marketing purposes [10] and [11]; [3], improving service encounters [4], and for increasing customer service [1].

Despite the growing body of research in the area of small business Internet use, adoption of Internet technology amongst small firms is still slow. [25] and [1] have commented that many small firms have difficulties realizing the benefits of Internet technology. Similarly, [2] found that small firms devote little consideration to practical questions of Web site management. Research on the barriers to adoption of Internet technology amongst tourism and hospitality businesses is very limited, but the main concerns seem to be security [16]; [17], lack of technical expertise [6]; [31], the difficulty in analyzing and promoting the site [1], the fear of losing client rapport ([18]; [21], and simply a lack of an online market for the firm's products [31]. For small firms in the tourism sector [28] ranked the four most important barriers as start-up costs, lack of staff expertise, operating costs and the difficulty of providing adequate training.

II. Methodology

Initially, in-depth interviews with a convenience sample of 15 B&B owners were conducted in Alberta, Canada during the winter of 2003/2004. The main reason for conducting these interviews was to ensure that the online survey was comprehensive and captured all the relevant data. Grounded on material generated from the literature review, the interviews questioned about owners why they used the Internet (i.e., to market rooms, increase exposure, project a professional image, etc.); what factors influenced or constrained their use of the Internet; how much they used e-mail as a marketing or communication tool or as a vehicle for taking reservations; what were the key advantages and disadvantages of using the Internet; what were success strategies for converting surfers to buyers; and how they advertised their Web sites.

What was clear from the interviews is that the Internet has emerged as an important marketing tool for B&Bs with demonstrable impact on the bottom line, and has proved to be a cost-effective marketing option, especially when partnerships are formed. Most owners reported spending a large proportion of available marketing dollars on the Internet, and receiving the majority of their reservations from Web based marketing. Most of the operators are

selecting to put much of their available Internet promotions budget towards maintaining a paid presence on area online destination guides or even to combine in geographical regions to develop new online destination Web sites.

Based on the analysis of these interviews, and on the relevant literature reviewed, an online survey was developed and hosted on a university Web site. Comparative studies have shown online surveys result in the potential to reach higher numbers of people and achieve higher response rates while being cheaper to administer, especially for larger sample sizes [7]; [32], even if initial costs are higher than other survey methods. The relative speed and flexibility of online surveys are seen to be two major advantages. Additionally, there is the potential of reaching a large and growing audience of people on the Internet.

Despite the limitations associated with sample selection, the universe of online users (both business-to-business users and consumers) has grown to the point where it is considered a sub-group of such importance that it is worthy of study in itself – without the questionable practice of attempting to project these findings back to the more general, off-line population. Certainly, for targeting small business owners in a survey of how they use the Internet, an online survey would seem highly appropriate.

The survey instrument was piloted with 12 B&B owners in Alberta, and based on their feedback, the survey was further refined. Subjects were then recruited with a personal e-mail that directed them to the Web site to complete the survey. An e-mail address list of 1048 B&Bs was compiled from all the available guidebooks, online guides, and brochures. This approach was adopted given large e-mailing lists work better with some degree of personalization [26].

The questionnaire was divided into four sections. The first part asked respondents about their Web sites; years of operation, percentage of reservations made on the Web, reasons for having a Web site; dollars spent on the Web site; and tools they use on the Web sites. Secondly, perceived advantages and disadvantages of using the Internet were examined. The third part asked respondents what efforts they made to convert surfers into buyers, such as developing relationships with customers, employing professionals to design the Web site and answering queries. The last section inquired about some of the characteristics of the respondents and their businesses. All questions were closed-ended to aid completion. The survey was “live” for one month early in 2004. A follow-up e-mail was sent after two weeks as online survey response rates may only reach 25 % without a follow-up e-mail [15]. In total 353 useable responses were collected, giving a response rate of 33.7 %. 270 responses were received within three days, similar to previous online studies [15], and supporting the contention that one of the major advantages of online surveys is the speed of response [32]; [7]. The data were analyzed using SPSS for Windows. Chi-square analysis was used to reveal any significant relationships between variables.

III. Results

Of the 353 respondents, nearly half (49%) were University graduates, 30% had trade diplomas, and the remainder (21%) were high school graduates. A large proportion (39%) were in the 55-64 age bracket, 33% were aged between 45 and 54, and 12% were over 65. The remainder (16%) were under 45. Results indicated that the Internet was the key communication tool for B&Bs. Table 1 shows that a large proportion (88%) of owners said that customers found them via the Internet “often” or “always.” This supports the data referred to earlier indicating the widespread use of the Internet amongst travelers. Word of mouth and accommodation guidebooks were the second most popular communication tools. According to [27], word of mouth is far and away the dominant force in the marketplace, yet it is also the most neglected. A quarter of respondents were in the first two years of running their sites, 35% were in the third or fourth years of operation, and the remaining 40% had been operating their sites for five years or more.

TABLE 1

Communication Methods That Attract Bed and Breakfast Customers

How Customers Found B & B's	Often or Always	Never or Sometimes
	%	%
Internet	88	12
Word of mouth	62	38
Accommodation guidebooks	47	53
Tourist office/Chamber of Commerce	32	68
Brochures	31	69
Other guidebooks	17	83
In Canada, provincial or regional promotions	16	84
Signs	12	88
Magazines and newspapers	6	94
Direct mail	2	98

Respondents were asked why they had a Web site. Table 2 lists the reasons in order of importance. There is clearly a trend towards using the Web as a marketing tool and as an avenue for delivering information, although 56% do use the Web to make online reservations. A large percentage (83%) maintained a Web site in order to increase business exposure, and 81.5% used the Web to expand their customer base outside of Canada. These statistics are similar to those found in a past survey of B&Bs in Canada [18]. Web sites tended to be updated when necessary, and exactly 50% of respondents said they measured the efficiency of their sites.

TABLE 2**Reasons for a B&B Having a Web Site**

Reason for Having Web Site	% of B&B Owners Who Agreed:
To use as a marketing tool	92.3
To increase business exposure	83.0
To expand customer base outside Canada	81.5
To target more customers with less expense	81.0
To expand customer base within Canada	79.8
To answer questions about accommodation	78.4
To project a professional image	75.6
To impart knowledge quickly	71.3
To use e-mail as a marketing or communication tool	71.3
To improve customer service	63.9
To make reservations directly	56.3
To provide quotes to customers	54.5
To level the playing field between small & big business	39.2
To offer paperless documentation	38.6
To obtain feedback from customers	27.6

Respondents were asked what tools they make use of on their Web sites. Very few used video or audio advertising, and only 16% offered information in other languages. The same low number used a secure server for making online credit card reservations. However, nearly half of respondents (46%) had links to other businesses to help customers make travel plans.

B&B owners were asked what they thought the advantages and disadvantages of using the Internet were. Table 3 lists these, in order of importance. Respondents clearly perceived more advantages than disadvantages, with internationalization and low cost being the main incentives for maintaining a Web presence. The majority of respondents (79%) also saw the ease of updating marketing information as a key advantage of the Internet over more traditional marketing tools. Building customer relationships was only seen by half the sample as an advantage of Internet marketing.

Security was seen as the greatest disadvantage of using the Internet. Interestingly, despite these concerns, only 14.5% used a secure server for online booking, and even less (5.7%) included a privacy policy. Another disadvantage perceived by 41.5% of respondents, was the inability to screen customers. Losing customer or client rapport has been highlighted before as a concern for small business owners [21] and in the interviews that preceded this survey, some of the owners had indicated that they still prefer to speak to potential customers on the telephone before taking a booking. [18] also found that B&B owners were concerned about the lack of rapport with clients and considered this drawback as an impediment to generating sales. Previous research on small firms without Web sites has found that

personal contact with customers through telephone conversations is very important for securing international sales [2].

TABLE 3**Advantages and Disadvantages of Using the Internet (B&B)**

Advantages	%	Disadvantages	%
Can reach a worldwide marketplace	89.8	Not secure	44.0
Low cost	81.0	Cannot screen customers	41.5
Ease of updating information	79.0	Poor technical knowledge of owners	41.3
Interactivity	65.3	Customer privacy concerns	31.8
Building customer relationships	51.4	Too long to develop Web presence	25.0
Measurement of efficiency	45.7	Customers more likely to cancel	17.9
Transmission of sound and video	44.6	Cost	7.7
Customer belief in security	6.3		

Respondents were asked what they did to convert surfers into buyers. Table 4 ranks the methods used and also indicates any statistically significant relationships between methods and Internet reservations. The most popular methods were to answer queries within 24 hours (86%), provide as much information as possible (85%), keep the Web site up to date (71%) and make it easy for customers to reserve a room (63%). There was a significant relationship between the number of reservations made via the Internet, and answering queries within 24 hours ($\chi^2 = 12.64$, $df=5$, $p<.05$), supporting the results of the in-depth interviews. Making it easy for customers to reserve ($\chi^2 = 16.31$, $df=5$, $p<.01$), was also a factor relating significantly to bookings taken.

Nearly 60% of owners felt that employing professionals to design the Web site assisted in converting surfers into buyers, although there was no relationship between doing this and Internet reservations. However, those that improved their Web sites based on customers' observations were significantly more likely to take Internet reservations ($\chi^2 = 13.56$, $df=5$, $p<.05$). There was a significant relationship between Internet reservations and the use of links to local businesses on Web sites ($\chi^2 = 15.86$, $df=5$, $p<.005$). This supports both the qualitative research, and [25] claim that the success of e-commerce for small business depends upon the adoption of technology by other participants. There was also a significant relationship between those that

developed relationships with customers and the number of Internet inquiries that turned into reservations ($\chi^2= 17.27$, $df=5$, $p<.005$).

TABLE 4

Methods used to convert surfers into buyers

Methods	% of B&B Owners Who Agreed	Significant relationship to Internet reservations
Answer queries in 24 hours	85.5	$p<.05$
Provide as much information as possible	84.4	ns
Keep Web site up to date	70.7	ns
Make it easy to reserve a room	62.2	$p<.01$
Employ professionals to design the Web site	57.1	ns
Develop relationships with customers	53.1	$p<.005$
Have links to local businesses on travel plans	46.0	$p<.005$
Improve the Web site based on customers' observations	46.0	$p<.05$
Offer a 1-800 number for fulfillment	43.8	ns
Avoid the use of gimmicky technology	43.2	ns
Provide contact information on every page	38.9	ns
Develop simple and persuasive messages	34.1	ns
Provide references or personal comments	32.7	ns
Clearly identify the target audience	16.8	ns
Use a secure server for online booking	14.5	ns
Offer a lower/discount rate online	6.3	ns
Include a privacy policy	5.7	ns

ns=not significant

Chi-square analysis revealed other important relationships between variables. There was a significant relationship between those respondents that measured the efficiency of their sites, and the percentage of Internet inquiries that turn into reservations ($\chi^2= 15.73$, $df=5$, $p<.01$), suggesting that measuring efficiency of Web sites can result in increased Internet bookings. There was also a significant relationship between growth rates (in terms of overall bookings) and the years of operation of businesses ($\chi^2= 15.878$, $df=3$, $p<.001$), and the years of operating Web sites ($\chi^2= 22.034$, $df=6$, $p<.001$). This would tend to support the contention that small businesses are using the Internet in order to grow their businesses without expanding physically or incurring relocation expenses [19].

There was a significant relationship between the number of years of Web site operation and the number of Internet

inquiries that turn into reservations ($\chi^2= 24.47$, $df=10$, $p<.01$), indicating that more experienced operators were more adept at converting surfers into buyers. Finally, there was a significant relationship between the number of years of Web site operation and international bookings ($\chi^2= 18.76$, $df=9$, $p<.05$). This supports the contention that internationalization is positively affected by use of the Internet [8]; [22]; [12]. However, there was no statistical support for Davis and Harveston's suggestion that education level and the age of owners influence Internet success.

IV. Discussion

The results of this study suggest that B&B owners are using the Internet as a low-cost method of increasing their customer base especially from overseas markets. Success is closely related to online experience, the measurement of Web site efficiency, prompt responses to inquiries, making it easy for customers to reserve, the development of relationships with customers, customer adoption of technology, and the existence of online partners. These results support previous research referred to earlier in the article [10]; [28]; [9]; [8]; [25]. The findings also support previous research that has found a positive association between small businesses Internet use and growth [19]; [8], and internationalization [21]; [22]; [12].

However, B&B owners do not use the Web to its full advantage, supporting contentions that the use of online marketing efforts has been relegated to a relatively small number of marketing tools and tactics [5]; [2]. For example, few respondents in this study used the Internet to solicit feedback from guests, and only half used it to build customer relationships. However, the Internet can be a powerful tool for relationship marketing purposes [3]. Most marketers now accept that it is less expensive to attract repeat customers than to create new ones and this is the basic concept behind relationship marketing. In addition, many consumers too are looking to build relationships on the Web.

Respondents in this study are also missing out on the potential to make more Internet reservations. Only 15% of owners used a secure server for secure online booking, and only 7% had a privacy policy, even though they identified security as being the major disadvantage of using the Internet. Previous studies have shown that security concerns are a major reason consumers do not buy online [29]; [1], even though these concerns may be exaggerated. It would seem that the investment in secure servers would result in increased online bookings for B&B owners.

Finally, only half of the respondents measure the efficiency of their sites, despite the positive relationship with Internet bookings. Simple measures exist that can assess the effectiveness of a site, such as hits (the number of times a site is visited), unique visitors (the number of different viewers during a particular time period), and page views (the number of times viewers view a page). Inexpensive software applications are available that small businesses can use to

carry out these measurements.

In addition to examining critical issues surrounding the use of the Internet for small businesses, this study has also highlighted the potential of online surveys as a way of increasing response rates in a cost-effective manner. Without a follow-up email, the response rate achieved would have been 25% within three days of initial contact. A review of 180 mail surveys of business respondents in the 1990s calculated the average response rate to be 21% [23]. Clearly, a carefully designed, targeted online survey of small business owners can surpass this average. However, this survey population had a high degree of interest in the topic of the survey, and there may have been a novelty factor that encouraged responses.

However, non-response remains a problem. People change their e-mail addresses more often than they change their phone numbers [7], and it is a challenge to find e-mail lists that are fresh [26]. In this survey, 55 e-mails were returned from a total of 1048 (approximately 5%). Fortunately, researchers were able to find new e-mail addresses for 30 of these, although this was a time-consuming process. One advantage of using online surveys is the instant feedback of undeliverable mail. In the future, it is likely that researchers will have access to up-to-date commercial e-mail lists similar to today's mailing lists, both reducing the effort of obtaining and increasing the accuracy of e-mail address lists. If respondents from these lists can be targeted to be representative of a desired population, the logistics of e-mail surveying will be greatly enhanced.

V. Conclusion

This study suffers from a few weaknesses, mainly in sample selection. The sample was limited to just one industry (hospitality), and to one particular sector of that industry (the accommodation sector). Therefore, the results may be of only limited generalizability. The sample may suffer from a strong element of self-selection, since it included only small firms that were online and thus did not include firms who had made the decision not to go online. Caution should be given to the interpretation of survey results obtained from a self-selected sample [14]. The sample was biased towards English speaking firms, and therefore the results may not be applicable to the whole of Canada. Internet use is higher in Western Canada and Ontario than it is in French speaking Quebec [30]. Finally, the study was biased towards Canadian-based firms. This may be problematic since researchers have found that the motivations and barriers to Internet adoption can differ across national boundaries [24].

Further research is also needed to determine why customers are reluctant to make reservations on the Web. [18] discovered that although many people are browsing the Web pages of B&Bs, these consumers are not using the Internet to make reservations. An Internet-based methodology to investigate the effectiveness of B&B Web sites, and the behavior of visitors online would be a natural extension of this research.

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Gauging Internet Buying Behavior – An Empirical Study on Indian Internet Users

A M Sakthivel*, Bishnu Priya Mishra**

* Assistant Professor – Marketing Area,
Loyola Institute of Business Administration,
Loyola College, Nungambakkam, Chennai 600 034. India
Ph: 0091-98842 89245

sakthi@yahoo.co.uk

** Reader in Management,
Regional College of Management,
Bhubaneswar. Orissa. India
Ph: 0091-674 – 2302535

dr_b_mishra@yahoo.co.uk

Abstract: The role of Internet has been rapidly becoming inevitable to corporate and society. Across the world, governments and corporate have been working towards the better utilization of the internet. Initially, the Internet was perceived as communication media and now, slowly, metamorphosing into a powerful business media. The Internet provides a direct reach to end users, thereby, the corporate wish to use this to gain cost competitive edge. Many dot.com companies entered and exited the cyber space during early twenty first century, yet, many dot.com companies survived and succeeded in their business. Many brick & mortar companies intended to use the Internet and found they it did not work well. The faced the peculiar lacuna of misunderstanding Internet buyer behavior and could not figure out the categories of products/services the Internet users intend to buy. At this juncture, the authors did an extensive primary research among Indian Internet users in order to identify the willingness of Internet users to buy different products/services over Internet. Besides, they also found the status of Internet users in buying different products/services online. The authors focused on finding out which stage the Indian Internet user stands in consumer buying process. The research revealed positive outcomes which would be useful to corporate world to adopt and deploy for better use. This paper mainly focused on consumer perspective of Internet purchase in order to understand Indian Internet users psyche.

Keywords: Internet Marketing, Internet Buying Behavior, Consumer Buying Process.

I. Introduction

The Internet has started been transforming from Information and communication media to Business media as many companies across the world perceived the potential of this magic media to reach potential consumers in leaps and bounds of the world. Many conglomerates used this as a media to sell their products/services and used their own

models or thumb rules. Unfortunately, the companies involved in this cyber business could not find proper direction to woo the potential consumers. Yet, they did not shy away from their effort to push their products/services hard towards the consumers. Very few companies like Amazon.com involved in selling different products have started making profit out of this business and many burned their fingers very hard way such as Webvan.com, online grocery retailer etc. due to lack of proper business and revenue models. Finally, the companies identified that not all products/services could be sold over Internet and certain products/services could be sold. Hence, many companies changed their strategies and started using their websites as an information media to create awareness among the target group, which would help them to make their offline purchase.

I. 1 Need, Relevance and Significance of the Study

The authors understood the needs of the companies that desperately trying hard to figure out the exact profile and buying behavior of online buyer. Many research works have been done in abroad, especially in USA, yet the significant outcomes about exact profile and buying behavior of online consumers to be figured out. As far as Indian soil is concerned, the marketing research companies found out the browsing habits such as hours of browsing, place of browsing, purposes of browsing and products/services purchased online etc and continued to do so in these areas. They have not gone deep in analyzing the buying behavior of Indian consumers over online purchases. The authors identified this wide gap and defined a problem to find out proper solutions about the impact of cyber-marketing in consumer buying behavior and their perception about using Internet either an information or business media. The paradigm shift in Indian soil left the population to adopt the changes related to different aspects such as technology, life style etc. In this process, many became the ardent users of Internet users mainly for exchanging communication through e-mail, online chatting (real-time conversation –Non voice mode), downloading interested information, music, pictures etc. for free of cost. Some of the companies tried to make extension of these habits by providing paid e-mail

services, which faced a debacle (e.g. Indiatimes.com in India and Netaddress.com in USA). The online users backed away when it comes to paying money for services they enjoyed free of cost. Some of the companies tried to extend this by offering products even groceries online (Fabmart.com in India, Webvan.com in USA). Many followed suit such as Chennaiibazaar.com, Bababazaar.com who act as a platform between buyers and sellers and enable them to make transactions over Internet. Some of the online retailers offer different variant of products (Fabmart.com etc) and some of them stick to certain products (First and second. Com) such as books, adopted the model of Amazon.com. Many entered into service arena by offering different services such as online share trading, banking, travel and hotel booking, holiday packages etc (Sharekhan.com, ICICIDirect.com, Makemytrip.com etc). Yet these online products/service providers could not reach the mass segment due to several infrastructure hiccups such as payment mode and logistics. It is identified most of Internet buyers in India prefer to buy CDs, Music, Books, Travel booking, holiday package online (TNS Interactive Global e-commerce Report 2002 and Web metrics 2002) This clearly shows that Internet buyers prefer to buy products/services do not need much of physical purchase as the trust plays a major factor in influencing target group's buying behavior as most of them prefer to do physical purchase (Tangible purchase i.e. touch, see, smell and feel products). In this study, the authors mainly focused on identifying the stages of consumers while they intend to make their purchase online. Normally In physical purchase, every consumer would undergo a three-tier process while he intends to buy a product/service such as cognitive (Information search), Affective (Evaluation of the information/alternatives collected/identified) and Behavior (make a purchase). The length of the above process would differ according to the investment he would intend to make on a product/service i.e. consumer involvement in purchase differs according to the investment he/she would make.

This is the crux of the authors' defined problem as they defined three types of products/services such as High involvement, medium involvement and low involvement. Involvement would be defined by four major factors viz. Price, Purchase intervals, Perceived risk and Personal emotional involvement (Ramesh Kumar S & Karan Bajaj, 2002).

High Involvement: Normally, a consumer would undergo a lengthy behavior process while he intends to buy high investment product/service such as TV, Car, Music System, Jewelry, Loan for House, Car, International holiday package, Investment of Funds etc. Hence, higher the investment, more the involvement the consumer exercise to buy a product or service as he could not switch to substitute brand or service as the investment is high. The products with higher prices, higher perceived risk, higher purchase intervals and high emotional involvement products such as Automobiles, Refrigerators etc. (Ramesh Kumar S & Karan Bajaj, 2002).

Medium Involvement: Generally, a consumer would

not exercise diligent care while he intends to buy a shirt, Fashion articles, selecting a domestic holiday package, booking a hotel room as it involved medium investment. Normally, all these purchase come under impulse purchase and the consumer would not use the articles for a long time and he/she may switch to substitute brand or service as the investment is medium.

Low Involvement: Usually, a consumer would not spend much time in searching information (cognitive) or evaluating (affective) the information collected before make a purchase (behavior) of FMCG products or perishable products or buying cinema tickets or booking a table at restaurant etc. which incur low investment as he/she could switch to substitute brand if dissatisfy with the product/service consumed. He/she could do so as the investment for the product/service is comparatively low and would not affect his/her buying decision. The products with low price, perceived risk, purchase intervals and emotional involvement products viz. Detergents, Cereals etc. (Ramesh Kumar S & Karan Bajaj, 2002).

Hence, the authors used the above-mentioned categories as the core aspect of the research as they identified the striking similarities between offline (physical) and online (purchase over Internet) purchase as consumers exercise same diligence of going through a lengthy process before buying a product/service (Fader 2002). So, the authors intended to identify the stages of consumer behavior process in which a consumer stands while he/she intends to use Internet a media to make his/her buying decision on different categories of products or services mentioned above. This would act as an eye-opener to the needy companies in Indian soil in order to identify the perception of consumers about utilizing the Internet to make purchase and also help them to devise strategies and upkeep their focus on wooing consumers to buy online.

The authors used to observe the dynamics of cyber-space from Internet to e-commerce and developed an interest to focus on analyzing consumers' perception on Internet especially about the utilization of former as information or business media. Also, they intended to analyze Internet users' willingness to buy product/service online. In order to identify their willingness, they intended to know the stand of consumers' in different stages of buying behavior in buying different categories of products/services online. They also observed the attempt made by many marketing research companies in identifying consumers' perception over Internet, but to in trivial areas like browsing habits, purposes, hours, place of browsing etc. None of the companies attempted to venture in depth to find out the behavioral process behind their purchase over online. Since, the selected problem is in very evolving stage as they witnessed the gradually transformation of Internet users to buy products/services online, but not in very encouraging trend as it is identified only 4% of Internet buyers from India buy over online against the global average 15% (TNS Interactive Global e-commerce report 2002). The study would be expected to unearth many queries, which eagerly waited by

many companies who desperately need to create a new segment of potential buyers in the cyber space and also would help them to make a proper positioning of product/service instead of placing all products/services online.

II. Literature Review

The importance of studying consumer Internet behavior as e-commerce grows in size and gaining significance and consumer researchers ought to take more effort to studying consumer Internet behavior on how consumers make the Internet a part of their consumption (Peterson, et al., 1997; Cowles and Kiecker, 2000). identified that the Internet is used as a more proactive marketing tool, inviting consumers interactively to access the web site to gain product information to facilitate their buying decision making process either online or offline Hazel, 1996). E-commerce managers/companies to understand the factors influence consumers buy online, so that they can develop effective strategies to encourage consumers to their web sites to spend time and money (Aldridge et al., 1997; Wysocki, 2000). It is found out that likelihood of buying should increase with increased use of the Internet. It vividly expresses that more exposure consumers gain over Internet would instill a trust in the media to move on to buying online (Aldridge et al., 1997). It is explained that the Internet has been used to facilitate online sales such as it acts as a means of communication about the companies sell product/services online/offline (information and communication media as it extends consumers ability to procure maximum information at their door step) (Bruno, 1997). The consumer online behavior has shown that attitudes toward the Internet and toward online buying are systematically related to online buying behavior. (Eastlick and Lotz., 1999; Goldsmith and Bridges, 2000; Karson, 2000; Kartz and Aspden, 1997). It is found from many US examples support that more consumers use the Internet for research (evaluation) in the early part of buying decision-making process, than buying direct on the web. It subsequently led to purchasing the product by store or order on the telephone or fax (Ernst and Young, 1999). The significance of Internet Consumer behavior is attracting increased attention from Marketing and Consumer Researchers (Donthu and Garcia, 1999; Phau and Poon, 2000). The domain of activities are identified which could be called "Consumer Internet Behavior" that included Information gathering, consumption of information through exposure to advertising, shopping, which includes browsing, comparing products and deliberate information search, and online buying of goods, services and information (Goldsmith and Bridges, 2000) It is found that most of the researches on Consumer Internet Behavior have normally been descriptive in nature, focusing on gathering statistical information on products/services online and the demographic profile or characteristics of online buyers in order to give a glimpse of online consumer profile (Modahl, 2000; Murphy, 2000). It is identified that those who use the

Internet more are likely to buy more online than those who use it less and providing logic of more usage of Internet might induce consumers to gain more exposure which might lead to more trust over Internet activities. This might be the earlier stage of exercising purchase behavior over Internet by collecting information as the consumer believed the reliability of the information available over Internet (Feather, 2000). It is found out that the consumers those who gained experience with online buying with a small purchase at the earlier stage will likely to develop confidence and skills that facilitate more ambitious purchase. It clearly shows that the more experience will instill trust in consumers to buy expensive products over Internet (Seckler, 2000). It is identified that consumers who frequently seek product information online are more likely to engage in web purchasing. This trend is confirmed through overall purchase and all nine individual product categories. It vividly portrays the acquiring information about products/services over Internet is the positive approach that consumers exercise towards the Internet which may likely to turn out to be future purchase (Hyokjin et al., 2002). The study portrays that 60.5 % of the users considered Internet to be a very important or extremely important source of information (UCLA, 2003)

Yet, the authors could not obtain much of preceding work in Indian context for the defined problem of the impact of cyber-marketing on consumer buying behavior as he resorted mainly to reportorial data than the behavioral data especially in context to Indian soil. Though, Many authors in abroad studied and analyzed the behavior of consumers over Internet, yet, not very much in line with the defined problem. Albeit, the authors collected data related to browsing and conversion behavior of consumers related to United States of America with respect to certain web sites dealing selected products, not of wide perspective, which the authors selected for the study. Nevertheless, the data provided a tremendous help to the authors to lay a path to unearth many outcomes, which may be potential solutions to target group (companies looking for exact profile of Internet-buyer and her buying behavior related to different products/services).

III. Main Issue of the Paper

To understand the position of Indian Internet users in different stages of consumer behavior in buying different categories (High, Medium, Low) of products and Services over Internet.

IV. Methodology

The authors selected Bangalore, the Silicon Valley of India, as the reach location as it houses the population who has high technological quotient, computer and Internet knowledge. The study mainly focused on collecting primary data from the selected samples (N=570) from Bangalore. The probability and non-probability sampling techniques viz. quota sampling (Internet Users), Cluster sampling

(Bangalore), Stratified Random sampling (selected respondents represent different demographics of the population), Judgment sampling were used to provide fairly accurate outcomes for the study. Structured questionnaire comprised of 6 divisions. 3 divisions dedicated for products and 3 for services. The authors mainly used 5 point Likert Scale to gauge the willingness of the Internet users to buy over Internet. The questions in each division had been divided in to three major areas viz. Information, Evaluation and Purchase. The crux of the research is to identify which stage the Indian Internet users in buying different products/services online. The authors used Principle Component Factor Analysis to validate the primary data. 18 factors had been selected for analysis. Necessary tests had been conducted and outcomes were satisfactory and significant related to sphericity and sample adequacy (Refer Annexure). After the application of Rotated Component Matrix, 18 factors had been merged to 5 major components.

V. Results

In the 1st Component, the results showed more favorable towards utilization of services over Internet. Indian Internet users show more willingness to evaluate medium and high involvement services over Internet. The 2nd Component unearthed the psyche of Indian Internet users who shown more willingness in buying high involvement and low involvement products online. This behavior is very encouraging as the Indian Internet users intend to buy products as the Internet might provide a different experience (in terms of cost and product/model/feature comparison) than offline purchase. The 3rd Component and 4th Component portrayed that the Indian Internet users shown more interest in collecting information about low involvement products and services online. This vividly shows the Indian Internet users intention of collecting information about low involvement products in order to make offline purchase. This offers the competitive edge in having right information to buy right product to attain better experience. The 5th Component proved the Internet users' intention to collect information on medium and high involvement products online. It is evident from the study that the Internet users were agreed to the fact they intend to use Internet for evaluating services, buying products and collecting information, primarily about products.

VI. Suggestions to the Corporate World

The study is novel and unique nature of understanding the urge of Indian Internet users to use Internet to buy different products and services. The authors defined the problem for identifying the stages of internet users in consumer buying process in which it was identified that the users intend to evaluate services online, followed by buying products. Hence, Service bags the higher rating among the internet users with reference to online utilization. It is already proved that the Indian Railways subsidiary IRCTC has started

offering e-tickets over Internet which received overwhelming response. Also, banking, travel and tourism industry are the heavy spenders on online initiatives which received welcome response from the society. The corporate ought to take cue from the study, mainly focusing on right information for evaluation which instills trust among the Internet users. This would act as reinforcement for future consideration of internet purchase. The categorization of products and services and the stages of internet users would definitely act as eye openers. The companies sell products could focus more on providing right information online would ensure the purchase offline. Even, they could provide comparative analysis of competitors' products which would create a trust. The study clearly revealed the stages of the Indian Internet users in showing interest in buying different products and services online. The companies can device strategies accordingly.

VII. Scope for Further Study

This study conducted in Bangalore, India and could be conducted across the world with necessary modifications suitable to local culture and economic conditions. Moreover, the awareness and acceptance of Internet among the local population score more marks. This study would reveal many interesting outcomes and would solve the problem of understanding the psyche of Internet users in order to sell right products/services.

To conclude, the authors made an attempt to gauge the buying behavior of Indian Internet users towards buying different products and services through empirical study. The study revealed the services scored more marks than products. The internet users reached the stage of evaluating information online, which clearly shows the consumers believe the information available online are reliable. The scenario would change in future, where in, most of the internet users buy online to acquire right product/service to have better satisfaction and experience. This is the primary responsibility of the corporate world to take initiation, instill trust and acquire consumers online for their survival and success.

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ANNEXURE

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.			.881
Bartlett's Test of Sphericity	Approx. Chi-Square		3190.622
	df		153
	Sig.		.000

Rotated Component Matrix^a

	Component				
	1	2	3	4	5
MS_E	.856	7.924E-02	8.311E-02	-1.89E-02	-7.74E-03
HS_E	.802	8.080E-02	.152	-2.31E-02	-5.94E-02
MS_B	.699	.364	-1.90E-02	-2.27E-02	2.326E-02
HS_B	.691	.252	-.104	8.182E-02	-3.34E-02
LS_E	.654	.287	5.246E-02	-.105	-5.57E-02
LS_B	.601	.324	-.249	3.096E-02	5.747E-02
MP_E	.543	.449	.380	-6.34E-02	-.182
HP_B	.264	.757	2.645E-02	1.315E-02	8.498E-02
LP_B	.131	.730	.282	-4.45E-02	-2.17E-02
HP_E	.270	.618	-.318	8.344E-02	2.130E-02
MP_B	.386	.588	-6.68E-02	-.101	-.169
LP_E	.341	.496	.456	1.427E-02	-.246
LP_I	1.111E-02	3.399E-02	.762	.126	.212
LS_I	-.103	-5.01E-02	-7.21E-02	.795	-1.20E-02
MS_I	.211	.134	7.130E-02	.593	.219
HS_I	-.186	-.130	.303	.504	-.159
MP_I	-.231	.115	6.935E-02	-.101	.709
HP_I	.109	-.169	4.347E-02	.143	.639

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 8 iterations.

The Mapping between Business E-Marketing Mix and Internet Consumers' Decision-Making Styles in E-Commerce

K. M., Sam¹, C. R., Chatwin²

¹ Affiliation: University of Macau,

Address: Faculty of Business Administration, University of Macau, Av. Padre Tomás Pereira S.J., Taipa, Macao

Telephone: 853-3974740

E-mail Address: tonysam@umac.mo

² Address: School of Engineering, University of Sussex, Falmer, Brighton BN1 9QT

Telephone: +44 (0) 1273 678901

Abstract: As a result of the emergence of E-Commerce, e-marketing mix has been widely adopted by most businesses and companies. Currently, the tools of e-marketing mix are provided by the company web site so that the customers can decide whether the company portfolio of products and/or services suits their needs. If we can understand the psychological factors of customer behavior, businesses can know which customers are suitable. This paper presents the relationship between e-marketing mix of particular businesses and psychological factors of customer behavior in order to provide an easier way for both businesses and customers to find their target needs.

Keywords: Consumer Psychological factors, E-Marketing Mix, Internet Marketing

I. Introduction

As a result of the increased utility and bandwidth of Internet communications, the usage of web browsers has increased dramatically. Many users make use of browsers to get different types of information in different media such as text, graphic, animation, audio and video. Hundreds of businesses have exploited this great opportunity to create their own web sites that allow customers to purchase products directly from their browsers. Most commercial companies believe that they can generate a large amount of profit from the web.

Although many web businesses terminated operations or ceased to exist from April 2000 to December 2001, those e-retailers developed and introduced new internet-based marketing techniques (e-marketing), which have been widely considered in the formation of current marketing strategy.

Kalyanam & McIntyre (2002) identified more than 30 e-marketing tools in their review of: popular business press, research reports from industry, textbooks and the academic literature for e-marketing tools.

Before the electronic age, E. Jerome McCarthy (1960) introduced the 4Ps (product, price, place and promotion) standardization of the marketing mix as a core unifying construct. Later on, van Waterschoot and Van den Bulte (1992) pointed out that the components of "communication" address "barriers to wanting", whereas the sales promotion

function addresses "barriers to acting". They observed that "triggers to customer action" seem necessary in certain situations to induce the exchange. Hence, they termed sales promotion a "situational" function. On the basis of these distinctions, the marketing mix can be reclassified into the "basic mix" and the "situational mix". In additional, since the sales promotion mix can apply across the full spectrum of the basic mix (the rest of the traditional marketing mix), it is considered by van Waterschoot and Van den Bulte to be overlapping. The concepts developed by van Waterschoot and Van den Bulte (1992) can be summarized in the form of the following axioms:

Axiom 1: Marketing functions are the appropriate properties for the classification of marketing tools.

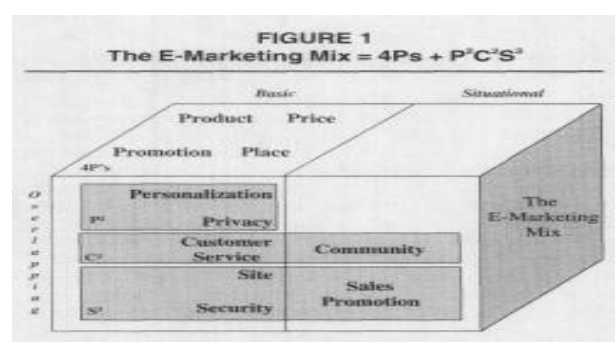
Axiom 2: Some functions are essential and others are situational in nature.

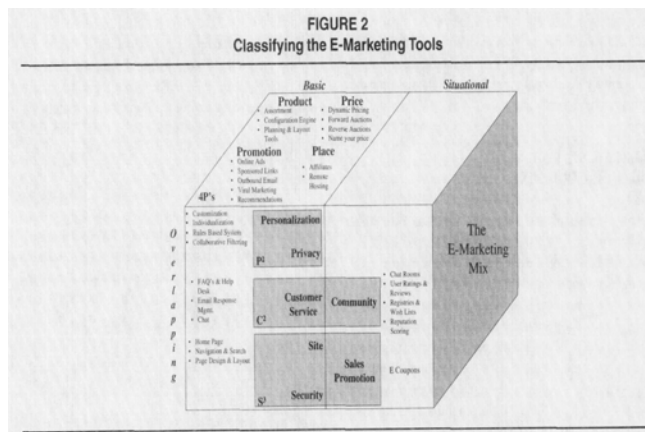
Axiom 3: Some functions have a moderating effect across other marketing functions and are called overlapping functions.

Axiom 4: Functions are accomplished by marketing tools.

Axiom 5: A tool can serve one or several functions.

Based on the above axioms, Kalyanam & McIntyre (2002) created a new E-marketing mix model as illustrated in Figure 1 and mapped the marketing tools and the terms in Table 1 to the new e-marketing mix model, as illustrated in Figure 2.





In the following tables (Tables 1A – 1D), four individual business web sites (randomly chosen) from each of the four types of businesses based on Sam K. M. & Chatwin C. R. (2005): Apparel, I.T. item, Jewellery and Car, are analyzed in terms of the e-marketing mix model from Kalyanam & McIntyre (2002).

Table 1A: E-Marketing mix model from Kalyanam & McIntyre: Apparel industry

Promod	La Redoute	River Islands	L.L. Bean
Product: <ul style="list-style-type: none"> Mainly for women outfit Allowing immediate effect on different colors Product features clear and simple. No multi-angle views. Very clear symbols for washing precautions Clear indication of available sizes Allow for exchange if items are not suitable 	Product: <ul style="list-style-type: none"> Target to both kids, men and women No immediate effect on different colors Long descriptions of product features No multi-angle views Simple washing precaution instructions Allow for ordering even though there is not enough stock Allow for exchange if items are not suitable 	Product: <ul style="list-style-type: none"> Target to both men and women No immediate effect on different colors Simple descriptions of product features No multi-angle views, but has closer views Simple washing instructions Allow for ordering even though there is not enough stock Allow for exchange if items are not suitable 	Product: <ul style="list-style-type: none"> Target to both men, women and kids Immediate effect on different colors Long descriptions of product features No multi-angle views, but has larger view Simple washing instructions Allow for ordering even though there is not enough stock Provide a user-friendly option for backorder situation Allow for exchange if items are not suitable
Price: <ul style="list-style-type: none"> Set up by the company 	Price: <ul style="list-style-type: none"> Set up by the company 	Price: <ul style="list-style-type: none"> Set up by the company 	Price: <ul style="list-style-type: none"> Set up by the company
Promotion: <ul style="list-style-type: none"> Outbound e-mails to registered users listing updated items Banner advertisement for free or reduced price delivery for some products Sales price available Some suggestions to create customers' look 	Promotion: <ul style="list-style-type: none"> Big discount sales price Online advertisement for half price 	Promotion: <ul style="list-style-type: none"> Free gift for sales over a certain limit Account card available to accumulate points to get cash voucher and discount promotions. Gift voucher available for free lucky draw 	Promotion: <ul style="list-style-type: none"> Big discount sales price Online advertisement for big discount
Place: <ul style="list-style-type: none"> Created in 1975 as a French family company, collections can be found in the chain of fashion shops and promod.com 	Place: <ul style="list-style-type: none"> Originated in France, providing different sites for different countries. 	Place: <ul style="list-style-type: none"> Many stores in UK and an international franchise presence. 	Place: <ul style="list-style-type: none"> Many stores in United States
Personalization: <ul style="list-style-type: none"> Follow-up individual customer orders after signing in. Get you to proper language version of site 	Personalization: <ul style="list-style-type: none"> Check whether your latest order has been processed Check your latest balance View your previous statements 	Personalization: <ul style="list-style-type: none"> Check for transactions and back-ordered items 	Personalization: <ul style="list-style-type: none"> Check for transactions and back-ordered items

Privacy: <ul style="list-style-type: none"> • Cookies created for processing and shipping of orders 	Privacy: <ul style="list-style-type: none"> • Cookies can track who has seen which web pages and any advertisements that may be placed on them and to track the effectiveness of online advertising generally. 	Privacy: <ul style="list-style-type: none"> • Cookies are used to keep track of where you are, which browser type being used, which pages have been visited, etc. 	Privacy: <ul style="list-style-type: none"> • Cookies are used to keep track of where you are, which browser type being used, which pages have been visited, etc.
Customer Service: <ul style="list-style-type: none"> • FAQ & Help available • Accepts comments from customers through on-line and give feedback through e-mail. 	Customer Service: <ul style="list-style-type: none"> • FAQ only for My Account • Accepts e-mail from customers 	Customer Service: <ul style="list-style-type: none"> • Help desk provided, convenient for customers to get more information • Accepts help through e-mail, phone or post 	Customer Service: <ul style="list-style-type: none"> • Help desk provided in different languages • Help information provided in different languages • Accepts help through email and phone.
Site: <ul style="list-style-type: none"> • Searching mechanism available through list box • Clear layout with white background color • Very clear classification of product 	Site: <ul style="list-style-type: none"> • No searching mechanism • Layout acceptable • Clear classification of product 	Site: <ul style="list-style-type: none"> • Searching mechanism available, but only through text box • Layout is OK. • Clear classification of product 	Site: <ul style="list-style-type: none"> • Searching mechanism available through list and text box. • Layout is quite good • Clear classification of product
Community: <ul style="list-style-type: none"> • None 	Community: <ul style="list-style-type: none"> • None 	Community <ul style="list-style-type: none"> • Hiring advertisement 	Community <ul style="list-style-type: none"> • Gift certificate
Security: <ul style="list-style-type: none"> • SSL protocol is employed during transaction 	Security: <ul style="list-style-type: none"> • Only mention with high confidence 	Security: <ul style="list-style-type: none"> • SSL protocol with 128-bit strong encryption is adopted 	Security: <ul style="list-style-type: none"> • SSL protocol with 128-bit strong encryption is adopted
Sales Promotion: <ul style="list-style-type: none"> • Promotional code offered. 	Sales Promotion: <ul style="list-style-type: none"> • Order Code offered. 	Sales Promotion: <ul style="list-style-type: none"> • None 	Sales Promotion: <ul style="list-style-type: none"> • Promotion code offered.

Table 1B: E-Marketing mix model from Kalyanam & McIntyre: Jewellery industry

Zoo Jewellery	Jazz It Up	Gold Jewellery	Mondera
Product: <ul style="list-style-type: none"> • Target to both kids, men and women • Product features simple and not detailed. • No multi-angle views. • Allow for return if items are faulty. 	Product: <ul style="list-style-type: none"> • Target to both kids, men and women • Product features simple and not detailed. • No multi-angle views. • Allow for money back within 7 days, but not for earrings or body jewellery 	Product: <ul style="list-style-type: none"> • Target market not mentioned • Detailed product features • No multi-angle views • Allow for product return • Offering different sizes and gold to choose when buying 	Product: <ul style="list-style-type: none"> • Target to both men and women • Detailed product features • No multi-angle views • Allow for product return • Customize the product by customers
Price: <ul style="list-style-type: none"> • Set up by the company 	Price: <ul style="list-style-type: none"> • Set up by the company 	Price: <ul style="list-style-type: none"> • Set up by the company 	Price: <ul style="list-style-type: none"> • Set up by the company
Promotion: <ul style="list-style-type: none"> • Outbound e-mails to users listing updated items • Big discount sales price • Banner advertisement for sale. 	Promotion: <ul style="list-style-type: none"> • None 	Promotion: <ul style="list-style-type: none"> • Outbound e-mails to users listing updated items • Discount for repeat buyers 	Promotion: <ul style="list-style-type: none"> • Outbound e-mails to users listing updated items
Place: <ul style="list-style-type: none"> • Physical store first Created in 1992 at England 	Place: <ul style="list-style-type: none"> • Based on UK. 	Place: <ul style="list-style-type: none"> • Online Jewellery store in Scotland 	Place: <ul style="list-style-type: none"> • Online Jewellery experts since 1999 in America
Personalization: <ul style="list-style-type: none"> • None 	Personalization: <ul style="list-style-type: none"> • Allow for remembering personal details 	Personalization: <ul style="list-style-type: none"> • Allow for keeping track of orders 	Personalization: <ul style="list-style-type: none"> • Allow for remembering personal details • Also allow for checking orders

Privacy: <ul style="list-style-type: none"> • Cookies created for processing and shipping of orders, also record IP address for monitoring web site performance 	Privacy: <ul style="list-style-type: none"> • Cookies can keep track of customers' names and addresses, etc. 	Privacy: <ul style="list-style-type: none"> • Cookies used to keep track of recently viewed products 	Privacy: <ul style="list-style-type: none"> • Cookies used to identify repeat visitors • IP address recorded for monitoring web site traffic performance
Customer Service: <ul style="list-style-type: none"> • Accepts comments from customers through on-line and give feedback through e-mail. 	Customer Service: <ul style="list-style-type: none"> • Accepts e-mail from customers about specific type of questions 	Customer Service: <ul style="list-style-type: none"> • Help desk provided • Accepts e-mail and other communication channels from customers 	Customer Service: <ul style="list-style-type: none"> • Help desk provided • FAQ available • Accepts e-mail from customers
Site: <ul style="list-style-type: none"> • Searching mechanism available through text and list box • Clear layout with white background color • Very clear classification of product 	Site: <ul style="list-style-type: none"> • No searching mechanism • Layout acceptable • Clear classification of product 	Site: <ul style="list-style-type: none"> • Searching mechanism available through text box • Clear layout with white background 	Site: <ul style="list-style-type: none"> • Searching mechanism through text strings or item number • Clear layout with white background • Clear classification of product
Community: <ul style="list-style-type: none"> • None 	Community: <ul style="list-style-type: none"> • None 	Community: <ul style="list-style-type: none"> • None 	Community <ul style="list-style-type: none"> • Can get more knowledge about jewellery • Wish list available • Customer rating available
Security: <ul style="list-style-type: none"> • SSL protocol is employed during transaction 	Security: <ul style="list-style-type: none"> • SSL protocol is employed during transaction 	Security: <ul style="list-style-type: none"> • SSL protocol is employed during transaction 	Security <ul style="list-style-type: none"> • SSL protocol is employed during transaction
Sales Promotion: <ul style="list-style-type: none"> • Promotional code offered. 	Sales Promotion: <ul style="list-style-type: none"> • None 	Sales Promotion: <ul style="list-style-type: none"> • None 	Sales Promotion: <ul style="list-style-type: none"> • Reference code offered

Table 1C: E-Marketing mix model from Kalyanam & McIntyre: I. T. items industry

Applied Computer	ComputersPlus	Circuitcity.com	Etronics
Product: <ul style="list-style-type: none"> • Product features simple and not detailed. • No 3D views. • Allow for return based on product manufacturer • No product photos provided 	Product: <ul style="list-style-type: none"> • Product features simple and not detailed. • No 3D views. • Allow for product if they are defective or wrong • No product photos provided 	Product: <ul style="list-style-type: none"> • Detailed product features • 3D view available • Allow for product return • Product photos provided 	Product: <ul style="list-style-type: none"> • Detailed product features • No 3D view • Allow for product return • Product photos provided
Price: <ul style="list-style-type: none"> • Set up by the company 	Price: <ul style="list-style-type: none"> • Set up by the company 	Price: <ul style="list-style-type: none"> • Set up by the company 	Price: <ul style="list-style-type: none"> • Set up by the company
Promotion: <ul style="list-style-type: none"> • None 	Promotion: <ul style="list-style-type: none"> • Outbound e-mails to users listing updated items • Sales price available 	Promotion: <ul style="list-style-type: none"> • Online updated news release • Sales price available • Banner advertisements appeared 	Promotion: <ul style="list-style-type: none"> • Outbound e-mails to users listing updated items
Place: <ul style="list-style-type: none"> • Based on the United States 	Place: <ul style="list-style-type: none"> • Based on the United States 	Place: <ul style="list-style-type: none"> • Physical stores in America 	Place: <ul style="list-style-type: none"> • Retail outlet at United States
Personalization: <ul style="list-style-type: none"> • Allow for remembering personal details and keeping track of orders 	Personalization: <ul style="list-style-type: none"> • Allow for remembering personal details and keeping track of orders 	Personalization: <ul style="list-style-type: none"> • Allow for keeping track of personal details and orders 	Personalization: <ul style="list-style-type: none"> • Allow for remembering personal details • Also allow for checking orders

Privacy: <ul style="list-style-type: none"> • Cookies created for recording customer personal information. 	Privacy: <ul style="list-style-type: none"> • Cookies can keep track of customers' personal information and visited pages, etc. 	Privacy: <ul style="list-style-type: none"> • Cookies used to keep track of recently viewed or purchased products • IP address may also be obtained 	Privacy: <ul style="list-style-type: none"> • Cookies used to identify repeat visitors • IP address recorded for monitoring web site traffic performance
Customer Service: <ul style="list-style-type: none"> • Accepts comments from customers through on-line and give feedback through e-mail. 	Customer Service: <ul style="list-style-type: none"> • Help desk provided • Accepts e-mail from customers 	Customer Service: <ul style="list-style-type: none"> • Help desk provided • Accepts e-mail and from customers • Accepts online chat with customers 	Customer Service: <ul style="list-style-type: none"> • Help desk provided • Accepts e-mail from customers
Site: <ul style="list-style-type: none"> • Searching mechanism available through text box, but quite detailed. • Clear layout with white background color • Not very clear classification of product 	Site: <ul style="list-style-type: none"> • Searching mechanism available through text box and list box • Layout acceptable • Clear classification of product 	Site: <ul style="list-style-type: none"> • Searching mechanism available through text box and list box • Clear layout with white background • Clear classification of product 	Site: <ul style="list-style-type: none"> • Searching mechanism through text and list box • Clear layout with white background • Clear classification of product
Community: <ul style="list-style-type: none"> • None 	Community: <ul style="list-style-type: none"> • None 	Community: <ul style="list-style-type: none"> • Providing job opportunity • Customer rating available • Gift cards available • Commitment to community – make life easier 	Community <ul style="list-style-type: none"> • Wish list available
Security: <ul style="list-style-type: none"> • SSL protocol is employed during transaction 	Security: <ul style="list-style-type: none"> • SSL protocol is employed during transaction 	Security: <ul style="list-style-type: none"> • SSL protocol is employed during transaction 	Security <ul style="list-style-type: none"> • SSL protocol is employed during transaction
Sales Promotion: <ul style="list-style-type: none"> • None 	Sales Promotion: <ul style="list-style-type: none"> • None 	Sales Promotion: <ul style="list-style-type: none"> • None 	Sales Promotion: <ul style="list-style-type: none"> • None

Table 1D: E-Marketing mix model from Kalyanam & McIntyre: Car industry

CarsDirect	Cars.com	Discounted New Cars	ComeBuy Cars
Product: <ul style="list-style-type: none"> • Target to new and used cars • Product features detailed • Only larger view. • Customize car features 	Product: <ul style="list-style-type: none"> • Target to new and used cars. • Product features detailed • Product photos provided, but only for larger view 	Product: <ul style="list-style-type: none"> • Target to new cars • Product features detailed • Product photos provided, but cannot be enlarged 	Product: <ul style="list-style-type: none"> • Target to used cars • Product features quite detailed, but not good enough • Some of product photos provided and can be enlarged
Price: <ul style="list-style-type: none"> • Set up by the company 	Price: <ul style="list-style-type: none"> • Set up by the company 	Price: <ul style="list-style-type: none"> • Set up by the company 	Price: <ul style="list-style-type: none"> • Set up by the company
Promotion: <ul style="list-style-type: none"> • Outbound e-mails to users listing updated items • Low price for new cars available 	Promotion: <ul style="list-style-type: none"> • Rebates available 	Promotion: <ul style="list-style-type: none"> • Online updated news release • Outbound e-mails to users listing updated items • Sales price available 	Promotion: <ul style="list-style-type: none"> • Online updated news release
Place: <ul style="list-style-type: none"> • Based on the United States 	Place: <ul style="list-style-type: none"> • Based on the United States 	Place: <ul style="list-style-type: none"> • Based on Australia 	Place: <ul style="list-style-type: none"> • Based on UK
Personalization: <ul style="list-style-type: none"> • Allow for remembering personal details so that buyer reports can be provided 	Personalization: <ul style="list-style-type: none"> • None 	Personalization: <ul style="list-style-type: none"> • Allow for remembering personal details for suitable cars 	Personalization: <ul style="list-style-type: none"> • Allow for remembering personal details • Also allow for checking orders

Privacy: <ul style="list-style-type: none"> • Cookies created for recording user behaviour at the web site. 	Privacy: <ul style="list-style-type: none"> • Cookies can keep track of customers' personal information and visited pages, etc. • IP address also recorded 	Privacy: <ul style="list-style-type: none"> • Not mentioned about cookies • Mention about personal information kept confidential 	Privacy: <ul style="list-style-type: none"> • Not mentioned
Customer Service: <ul style="list-style-type: none"> • FAQ provided • Help desk provided • Accepts comments from customers and give feedback through e-mail. 	Customer Service: <ul style="list-style-type: none"> • Payment calculator provided • Help desk provided • Accepts e-mail from customers 	Customer Service: <ul style="list-style-type: none"> • No help desk provided • FAQ provided • Accepts e-mail from customers 	Customer Service: <ul style="list-style-type: none"> • FAQ provided • Accepts e-mail from customers
Site: <ul style="list-style-type: none"> • Searching mechanism available through list box. • Clear layout with white background color • Very clear classification of product 	Site: <ul style="list-style-type: none"> • Searching mechanism available through list box • Layout acceptable • Clear classification of product 	Site: <ul style="list-style-type: none"> • Searching mechanism available through list box • Clear layout with white background • Clear classification of product 	Site: <ul style="list-style-type: none"> • Searching mechanism through text and list box • Clear layout with white background • Clear classification of product
Community: <ul style="list-style-type: none"> • Customer rating available 	Community: <ul style="list-style-type: none"> • Customer rating available 	Community: <ul style="list-style-type: none"> • None 	Community: <ul style="list-style-type: none"> • None
Security: <ul style="list-style-type: none"> • Using known encryption and security standards 	Security: <ul style="list-style-type: none"> • SSL protocol is employed during transaction 	Security: <ul style="list-style-type: none"> • Not mentioned 	Security: <ul style="list-style-type: none"> • Not mentioned
Sales Promotion: <ul style="list-style-type: none"> • None 	Sales Promotion: <ul style="list-style-type: none"> • None 	Sales Promotion: <ul style="list-style-type: none"> • None 	Sales Promotion: <ul style="list-style-type: none"> • None

According to the above comparisons, there are different e-marketing strategies used by different business web sites in a particular industry. Why are there different e-marketing strategies from different business web sites in a particular industry? It is due to the fact that their target customers are different. Figure 3 illustrates different requirements from customers and businesses:

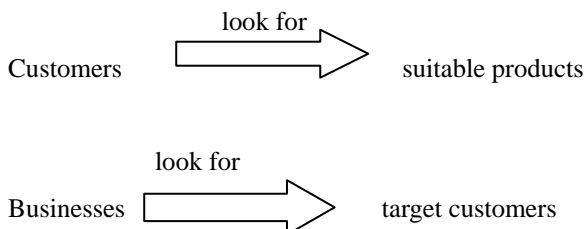


Figure 3: Different Requirements from Customers and Businesses

Services can be provided such that businesses can get only those target customers (relating to the e-marketing mix of a particular business) and at the same time customers can get their preferable products (relating to the psychological factors of customers). In this way, it is beneficial to both parties.

II. Psychological Factors of Customer Behavior

Based on the psychological factors from Sam K. M. & Chatwin C. R. (2005) of customer behavior, the following facts have been discovered:

1. Consumers have different psychological factors for different types of products
2. In addition to the psychological factors specific to product, it is necessary to consider the psychological factors specific to the web site (online business) as a result of the emergence of e-marketing.

According to (Retailers' Search Engines Boost Online Sales,

http://www.realseo.com/archives/cat_search_engines_news.html), there is a 40% increase in the total number of consumers who visited a retail website's search engine made an online purchase from 2003 to 2004. It shows that search engine has become more important. Online customers can enter search criteria, namely; budget, product features, brand name, portability and quality rating, to refine the product list displayed on screen (ref: http://www.spec-direct.com/Case_Studies.asp?page_id=17). Each of the above criteria is associated with a particular psychological factor of customer behaviour (Point 1 above) as shown in figure 4:

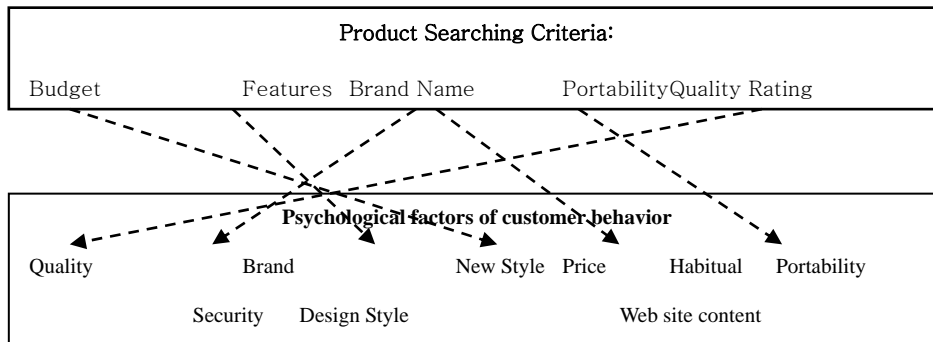


Figure 4: Relationship between Product searching criteria and customer psychological factors

III. E-Marketing Mix

E-marketing mix, when compared with the traditional marketing mix, should be designed in such a way that can reflect the current situation of E-commerce. The e-marketing

mix model designed by Kirthi Kalyanam & Shelby McIntyre (2002) can fully reflect the current situation by identifying basic and overlapping functions and mapping e-marketing tools to those functions. By integrating this e-marketing mix model with the diagram shown above, the following result is achieved, see figure 5:

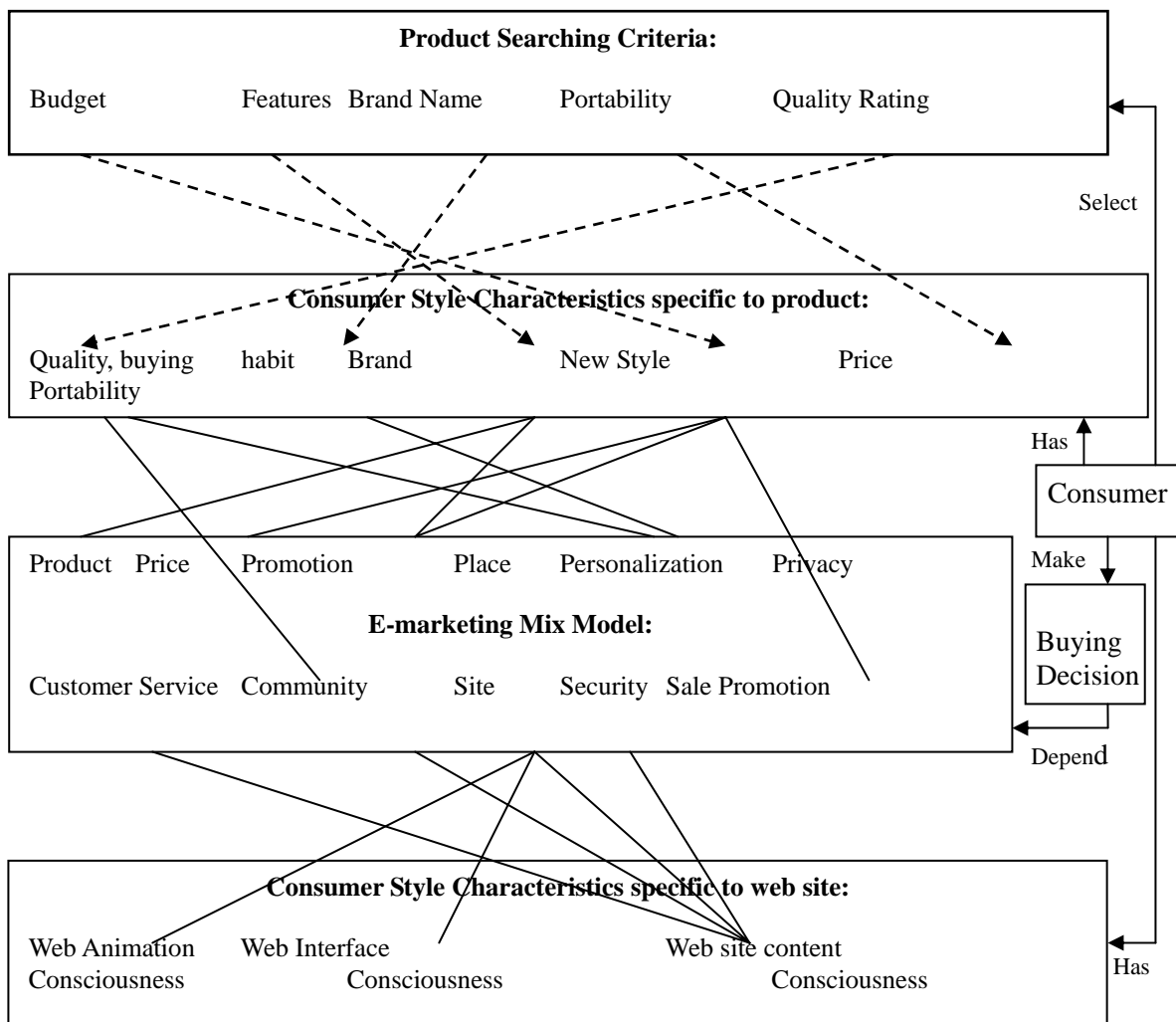


Figure 5: Relationship between E-marketing mix model and Internet Consumers' Decision-Making Styles

Relationship of E-marketing mix model & psychological factors specific to products

If customers demand new style products, they may prefer those web sites, which can offer customisation, allowing them to tailor-make their own products. In addition, they may also want those online businesses which frequently promote some new items on their web sites.

If the customers demand is for low price products, they may select those online businesses which can provide lower prices or e-coupon, or advertise sales promotions on their web sites.

If customers are getting used to particular brands or products, they may prefer those online businesses which can provide personalized services to them so that updated information about particular brands can be obtained easily.

If customers have a habit of buying the same high-quality products, they will be concerned about the user rating of these products and also the personalized services about the history of their purchasing records.

Relationship of E-marketing mix model & psychological factors specific to web site

If customers are annoyed by the effect of web animation and prefer a good design interface, only those web sites with less animation effects and a good user interface (e.g. list box) will be suitable for them.

If consumers make a high demand on the services (including searching, communication, security) and product information, those web sites which can provide: a strong searching mechanism, a good communication tool such as email facility, chat-room service, and a high security standard such as 128-bit encryption standard and detailed

product features - will be most suitable for them.

IV. Conclusion

By integrating the E-marketing mix model of a particular business with psychological factors of customer behavior, the target customers can easily be found. If only the target customers are allowed to enter the business web site and those visitors who are not their target customers are filtered out, it can reduce the workload on the business web site.

Furthermore, when more target customers are directed to a particular business web site, the business can generate more profits. One of the future enhancements of this paper is to develop an intelligent agent to provide convenience to customers as well as attracting more potential customers to business web sites based on the corresponding e-marketing mix of particular business.

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Effective Internet Marketing: An Integrated Approach Used By Educational Institutions

Indrit Troshani, Sally Rao
School of Commerce
The University of Adelaide
233 North Terrace, Adelaide, SA 5005
Australia
Email: {indrit.troshani, sally.rao}@adelaide.edu.au

Abstract: The internet and its various applications have been found to be very effective in delivering marketing functions in general and advertising in particular. This paper presents an integrated approach about the way different internet marketing strategies can be used for advertising the degrees of an educational institution using a case study method. This is an important goal for educational institutions in Australia. The paper culminates with a recommendation and a discussion about the ways in which this goal can be accomplished. Challenges associated with the implementation of this integration, including spam, internet market research and target market identification are also discussed.

Keywords: Internet marketing, advertising

I. Introduction

New media technologies, such as the Internet and the World Wide Web (WWW) have been found to be the most important factor in the future of marketing in general and advertising in particular [1,21,38]. The WWW has the potential to facilitate the consumer relationship marketing and the communication between producers and consumers all the way from acquisition to retention. This has had fundamental implications for marketing and advertising, because audiences can now be 'atomized' rather than just fragmented [19,21].

Different products can be marketed and sold via the WWW [4,6] and university degrees are just one type of product that can be advertised online via the WWW or other internet functions. The goal of the educational institution is to increase student numbers, including local and international full-fee paying students. This is important for several reasons. One of these reasons is that student fees constitute an important source of revenue for the educational institution. In addition, they also contribute to the economic growth of the state as onshore students are expected to generate demand for other goods and services in the state economy and therefore contributing to its growth.

On the other hand, using the internet to advertise university degrees is likely to reduce the advertising costs considerably, while reaching a wider target audience [24,25].

Internet features like ubiquity, global reach, standardization, richness, interactivity, information density, and personalisation and customisation, if exploited properly have the potential to make online advertising of degrees effective and efficient [25].

James et al. (1999) indicate that in Australia students have limited knowledge to decide what courses to study, prior graduate satisfaction, career prospects, teaching and learning approaches, and teaching quality [22]. In addition, research also shows that students base their choice on the reputation of the degree rather than the overall reputation of the university which is offering it. Other important factors include degree recognition, and value for money [18]. This suggests that relevant information appears to be one of the important critical variables influencing student choices. Therefore, when advertising a degree, information concerning the factors above should be provided to prospective applicants in one way or another. Marketing of degrees to international students is particularly important given their impact to Australia's economy. For example, in 2000 Australian education providers generated of AUD3.7 billion from overseas students [14]. In addition, research shows that over half of university students, use the internet to facilitate choosing overseas education [18]. Therefore, internet marketing of tertiary degrees is important.

The aim of this paper is to address the question of how internet marketing can help an educational institution improve marketing and advertising its degrees. The paper is structured as follows. In section two, three different alternatives addressing the goal are identified and explained. A justified recommendation is presented in section three. Section four explains the ways in which the recommendation will help accomplish the goal. Challenges associated with the recommendation are identified and discussed in section five. Finally, section six summarises the paper.

II. A Review of Internet Marketing Strategies Used By Educational Institutions

The objective of this section is to present three different ways to address the goal presented in the previous section. The internet marketing literature suggests that there are a variety of possible options that can be used, such as direct email, search engine registration, banner, pop-up and rich media advertising, public relations, promotions, cross-media advertising, etc [13,25,29]. However, due to space

constraints only the first three options which seem to be more popular will be considered in detail.

Direct eMail. Increasingly, direct e-mail is being used as an effective, inexpensive and easy way to target potential customers [12,13,23]. As potential students are essentially the potential customers of educational institutions, personalised direct email can also be used to target these students in an ongoing manner with specific and relevant information concerning the degree they might wish to study. Direct e-mail campaigns can either be carried out in-house or outsourced to specialised email marketing organisations (e.g. www.siebel.com). If they are carried out in-house considerations should be made whether the educational institution has the capability, in terms of staff and network infrastructure, to respond to the anticipated volume of emails or follow-up queries. Failure to provide adequate prompt and personalised replies may have serious consequences and lead to dissatisfied students, who will consequently not only lose trust and commitment [18] but also pass on their negative experience and impressions to others via viral marketing [8,24,25,35]. At best the education institution should engage in a continuous email dialogue with prospective students until their degree-related queries have been satisfied. This dialogue will help build a degree brand [20]. Providing query email addresses and giving email queries high priority is important as it establishes trust in prospective students. This is likely to improve the response rate of potential students to email marketing campaigns [13].

However, researchers estimate that by 2005 there will be as many as 35 billion commercial emails sent every day [12]. This suggests that email marketing is likely to become hyper-competitive, and may also be used by competing education providers who also wish to market their own degrees. Therefore, it is important for email marketing campaigns to be designed in such a way that they remain visible and distinct to the potential students.

Search engine registration. Thelwall (2000) provides evidence that web users use search engines as part of their strategies to find information in the Internet. Specifically, usability studies show that “slightly more than half of all users are search-dominant...” (Nielsen, 2000, p. 224). This is consistent with a study by Gomes and Murphy (2003) who found that nearly half of the students involved in the study used search engines to locate the web sites of tertiary education providers. Nevertheless, evidence indicates that there is a significant number of web sites that are not registered with the major search engines [44]. Thelwall (2000) explains that this is attributed to the misunderstanding of the importance of search engines by web site designers and by the lack of knowledge of how to get web sites registered and remain registered. As a consequence, it can be concluded that the designers of the web pages of education providers featuring individual degrees should make these pages “search engine-friendly” (Thelwall, 2000, p. 151) and register its individual degree web pages with popular search engines (e.g. Google, Yahoo,

Altavista, etc.) [31,32]. Typically, this is done by indexing and HTML META tag inclusion of key words in the HTML pages featuring degree offerings.

Banner, Pop-up and Rich Media Advertising. Banner ads represent rectangular promotional areas of a web site which display a promotional or advertising message using eye-catching animated images [13,25]. When clicked on, a banner ad redirects a visitor to the web site which it is advertising. While banner ads are embedded on a host web site, pop-up ads appear on the screen as separate windows without a user having to call them directly. Rich-media ads use Flash, DHTML, Java, and streaming video and/or audio simulating television [25]. These three means of advertising can be used to advertise university degrees, however, there are a few facts that have to be considered.

The web site hosting the banners should be carefully chosen depending on whether it is popular with potential students. In addition, congruity considerations should be made how the attitudes of potential students towards a degree are affected when they view banners on web site hosts. Research shows that if a banner ad is hosted on a web site, the ad should be congruent with its host, alternatively the attitudes of the potential consumers (or students) towards both the web site and the products advertised by the banner ad may be harmed [30] which is consistent with the cognitive consistency theory [15].

In addition, banner advertising can be quite expensive and its cost (e.g. click-through rates, cost per action, etc.) depends on the popularity of the host as well as the time of the day when the banner ad is displayed and when most traffic is expected. Besides, in an effort to generate additional revenue, some hosting web sites overuse banners, therefore, individual banners are likely to become invisible and obscure and consequently lose some or all of their impact. Research results concerning the effectiveness of banner ads are mixed. Some studies show an increase in consumer loyalty ranging from 5 to 50% for different products [16]. Other studies show that the click-through rates for banner ads are around 0.5% and this is continually decreasing [43] and this is also substantiated by [26]. However, even if banner ads may never be clicked, they may have an impact on the attitude of the a visitor, but most importantly, they help with degree branding [21].

Pop-ups while grabbing the attention of visitors, they can be also irritating and therefore have negative effects due to their intrusive nature [13]. Rich media ads can be effective. DoubleClick, reports that approximately 28% of online advertising included some form of rich media in their web ads during the first quarter of 2003. With rich media presenting opportunities to be interactive, users in general, and potential university students in particular, can be forced to interact with the ad in some fashion [25]. As a matter of fact, rich media ads are often used to replace static banner ads as research indicates that the former has been found to be more effective than the latter in gaining consumer attention [9]. However, in order for rich media ads to be

effective, fast internet connections, such as broadband are required.

Having examined the three alternatives above, we believe that they should be viewed as complementary rather than as mutually exclusive. Therefore, educational institutions should adopt an integrated approach using at least two of the alternatives explained above. At best, all three should be used in conjunction with each other [19,38]. However, any steps towards implementing combinations of the above should be geared towards acceptable levels of Return on Investment (ROI) as all of the options above require varying degrees of investment outlays.

For example, the direct email alternative may be implemented in-house or it may be outsourced. In both cases the educational institution may incur primary costs to purchase the list of names to which emails will be sent [25]. The direct email alternative, if implemented in-house will require additional resources, including staff hours and probably network infrastructure upgrades. It may also require the establishment of email reply policies and the designation of dedicated counsellors to provide advice to potential students [6,25]. This is likely to be highly effective as it provides the greatest degree of personalisation and customisation to direct email, which research shows that potential students are likely to respond to positively [5,25]. On the other hand, outsourcing direct email will increase the cost incurred by the education institution in terms of fees payable to the contracted third party direct email service providers, but yet, unless these liaise strongly with the university counsellors, the extent of advice personalisation and customisation may be questionable. This is likely to undermine direct email benefits.

Search engine registration is probably the most inexpensive alternative and should therefore be carried out under any circumstances. Generally most popular search engines do not require payment for registration, although some may offer additional services and charge for them [13,25,40,45]. The only cost incurred with this alternative consists of costs associated with the additional development effort to make these pages search engine friendly. Web site usability studies show that more than half of all web users are search dominant, one fifth are link-dominant, where as the rest exhibits mixed behaviour [31] which supports the recommendation further. In addition, search engines have a huge user base both locally and internationally. Therefore there is no reason for search engine registration not to be carried out [44].

Banner ads are generally considered effective in increasing reach as they are likely to increase the target audience considerably. However, careful consideration should be made when choosing the websites to host these ads. For example, appropriate sites could be high school websites, or web sites of national and international tertiary admission centres, etc. As suggested earlier, a lack of congruity between the banner ads the websites hosting them can adversely affect both [21]. Cultural considerations of the audience likely to receive the ads should also be taken into

consideration [35]. Clearly suitable payment schemes should be considered and organised between the education institution and the websites hosting the banner ads. Pop-up ads are probably a poor choice and may undermine the effect of the message they are trying to advertise due to their intrusive nature. Further, using rich media ads may not be effective at this stage due to the requirement of appropriate internet infrastructure, such as broadband. Currently, Australia is still lagging almost 2 years behind other developed western nations with respect to residential broadband penetration and adoption, suggesting that the placement of rich media in websites targeting an Australian audience may be premature for the time being [37].

In summary, a detailed cost-benefit analysis should be carried out. In addition, a multi-phased approach should be undertaken, whereby the above options are implemented as increments, rather than all together in a big-bang fashion [11]. The benefit of this approach is that the education institution can monitor and therefore control costs and continuously compare them against the generated outcomes. Following this approach, will also allow undertaking responsive adjustments when results are not satisfactory.

III. The Benefits of an Integrated Approach

The benefits of an integrated approach can be actualised in three ways [25]. First, using the internet as a medium, the internet marketing via direct email, search engine registration and banner ads increases significantly the number of potential students that can be reached. Second, the internet has the potential to increase the richness of the content that can be provided without sacrificing interactivity while maintaining adequate levels of personalisation and customisation. Third, the internet has greatly increased the information intensity which can be provided to potential students.

With direct emails, educational institutions can establish e-mail policies which can include training employees and using standards for email response times and formats. Prompt and personalised email responses constitute good customer/student service [33]. Continuous email communication with prospective students will help institutions create a degree brand [20]. After being de-identified to protect privacy, email communications with potential students can be systematically stored in databases and data warehouses for further analysis [34]. Data mining, which consists of various analytical techniques to identify patterns in databases or data warehouses, can then be used to create profiles, behavioural patterns, and demographics for potential students [2]. These are useful because they help education institutions understand the requirements of prospective students and consequently be proactive in satisfying these requirements [39].

The educational institution can even go the extra mile and establish a Prospective Student Relationship Management System (PSRM), which can be modelled after customer relationship management (CRM) systems. A

PSRM would support the institutions efforts to be student-centric and therefore treat potential students as individuals rather than use one-size-fits-all strategies to treat them equally as parts of a market segment [7,42]. While evidence suggests that using CRM-like systems can be effective, their initial introduction requires the establishing of a positive and fluid institutional culture [35,42].

The obvious benefits of search engine registration is that registered degrees are likely to be listed in the 'top-ten' hit list when prospective students carry out searches using search engines. Being included in the 'top-ten hit list' is important because nowadays the market for tertiary degree is highly competitive. Therefore, being part of a 'top-ten' hit list is a convenient way to stand out from the crowd. Essentially, search engine registration is the equivalent of placing an entry in a phone or yellow pages directory: it increases the chances of offered degrees to be easily located [13].

Clearly, the first benefit that is provided by banner ads is additional exposure of degrees to potential students. As discussed in the previous section, the other benefit of banner ads (even if they are never clicked on) is that the help with degree branding [21]. Clearly, if banner ads are clicked on, they have aroused the visitor's interest. Consequently, the next step is to satisfy the prospective student's queries. If the page the visitor is taken to upon clicking the banner ad, does not provide the required information, the effectiveness of the banner ad is likely to be quickly undermined. Consequently, items like, Frequently Asked Questions (FAQs), links to real-time prospective student service chat systems, automated response systems, site maps, and email addresses should be clearly identifiable in prominent locations or even elegantly included as hot spots in the banner ad [25]. If these are properly designed in the banner ads or pages the banner ads redirect a visitor, cost savings are likely to be realised, as prospective students are likely to find the required information from webpage pages without needing to contact designated counsellors.

IV. Challenges in Implementing an Integrated Internet Marketing Approach

One of the important aspects that the educational design of an online unit needs to take into consideration includes the resources that are provided to the learners [20].

Although the challenges faced by educational institutions are those inherited by internet marketers in other industry, the industry specific characteristics present them with challenges other than those previously experienced or identified by other marketers. Three main challenges are considered, namely, spam, internet market research, and identification of the target market.

SPAM. One important issue that might hinder the effectiveness of direct email marketing is spam, which is unsolicited commercial email [10]. According to Laudon & Traver (2004) 45% of all internet mail in the US was spam.

Gervois (2004) suggests that two thirds of the email received in most households in Australia and New Zealand is spam. The implication of this is that email sent by an educational institution to potential students is likely to be unsolicited and therefore runs the risk of becoming invisible.

Although anti-spam legislation came recently into effect in Australia the amount of marketing email messages continues to grow [3,17]. Although the Australian Communications Authority is making serious attempt to control spammers, email users are increasingly becoming comfortable with opt-in communications [17].

In this context education institutions should seriously consider two important issues. Firstly, they have to ensure that they do not violate the Spam Act. In order to achieve this three basic rules should be satisfied: a) messages may not be sent without the recipient's prior implied or express consent; b) messages should include accurate sender information; and c) messages should allow receivers to opt-out or unsubscribe from future messaging [3,36,47]. Secondly, upon obtaining permission from potential students for degree-related advertising emails, the education institutions, should be creative in their design to sent distinct and visible messages.

Market research. The rapid diffusion of computers, digital and telecommunication infrastructures allows marketers and individual potential consumers to interact in an individualised manner [27]. This is applicable to educational institutions and their potential students. In order to increase the effectiveness of the direct email and banner advertising educational institutions should conduct market research, which would provide insights into what sort of information need to be included in an email, the best ways to design effective ad banners, as well as to present degree related information to potential students. This is important because it helps the education institution identify the requirements to satisfy its prospective students' needs [39].

While this information can certainly be gathered using traditional market research (e.g. surveys, interviews, etc.), internet-based market research (e.g. online surveys, online focus groups, etc.) constitutes another option and should be seriously considered [13,46]. For example, internet market research surveys exhibit several desirable features, including ease of use and low cost, while the response quality and the response rate rapidity tend to be at least equal if not superior to the traditional forms of survey. According to the results of the study conducted by Wilson and Laskey (2003) internet market research is effective in reaching teenagers who are likely to be more difficult to access via traditional means (e.g. phone and postal surveys) and who are potential respondents for educational institutions [46]. However, internet usage patterns are likely to be different among different users, it is therefore also possible for the collected data not to be representative of the population. Consequently, internet based research should be used as a supporting method to traditional market research rather than as a substituting alternative [46].

Target Market. Another important consideration is the identification of the target market which constitutes an important strategic decision for an education institution in particular [28]. This is important because it helps the institution position itself in the eyes of its target market which will eventually affect the perceptions of the potential students about the degrees that are offered [41]. In the case of educational institutions which need to advertise their degrees, the target market would clearly include year 11 and 12 high school students, tertiary transfers, mature-age and international students. If direct email is used, individuals and their email addresses need to be identified first before they can be contacted. This identification is associated with privacy concerns [25].

V. Conclusion

The goal of this paper was to propose ways in which internet marketing technologies can be used to advertise tertiary degrees by education institutions. The goal of the paper and its motivation were explained in section one. Three alternative ways to address this goal were discussed in section two. These alternatives include direct email, search engine registration, and banner, pop-up and rich media advertising. The recommendation that these three methods are complementary and should therefore be used in conjunction with each other is presented in section three. The benefits that the proposed recommendation is likely to deliver to the education institution are covered in section four. Finally section five discusses some challenges that likely to be encountered if the recommendation is implemented.

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An Evaluation of the Fashion Web Sites in New Zealand

Winnie Wing Man Hui, John Paynter
Department of Information Systems & Operations Management
University of Auckland
Private Bag 92019, Auckland,
New Zealand.
E-mail: winniewingman@gmail.com; j.paynter@auckland.ac.nz

Abstract: A fashion web site provides consumers with the opportunity to search for information. It also enables them to shop unconstrained by time or location. This research evaluates the performance of the fashion web sites in New Zealand and examines how the web sites can improve. Forty New Zealand fashion web sites were examined using the web site evaluation model tailored for fashion sites. The results show that the majority of New Zealand fashion web sites are informational rather than transactional. Fashion web sites should focus on how to improve their web site quality and web site content in order to attract more potential consumers.

Keywords: Internet Marketing & Advertising, E-commerce.

I. Introduction

The number of Internet users is growing rapidly throughout the world. Growth in electronic commerce is explosive. Electronic commerce has impacts on how business is conducted and offers the possibility of extending or reinventing existing business models based on the openness and connectivity of the Internet [16]. Apparel products have become the third largest retail sales category on the Internet [5]. Many consumers are lured by the simplicity of online shopping experience from just browsing for fashion information to buying fashion products. New Zealand fashion organisations realise the importance of the Internet and that improvements in their web site are necessary to ensure they stay solvent. The Internet allows fashion organisations to establish themselves, promote their brand name and products. Fashion web sites need to attract those consumers most likely to buy in order to cover the costs of e-commerce and make a profit. Although some research on Internet fashion shopping behaviour has emerged, little attention has been devoted specifically to New Zealand fashion web sites. The purposes of this study are to evaluate the performance of New Zealand fashion web sites and to examine web site quality.

II. Literature Review

Not surprisingly, the number of Internet users around the

world is growing tremendously. The worldwide number of Internet users are projected an increase to 1.46 billion in 2007 [4]. Current figures indicate that the New Zealand Internet population has reached 2.34 million and this figure is anticipated to continue to increase [4]. New Zealand has a small domestic market and a high degree of technology adoption when compared to other developed countries [17].

Academic research indicated that the consumer is more inclined to look beyond traditional retail venues for shopping alternatives [2]. The New Zealand Official Yearbook (cited in [10]) states that 79% of New Zealand businesses have Internet access, which is higher than averages found in comparable Organisation for Economic Co-operation and Development countries such as Australia and Canada. Nearly every company web site in New Zealand provides lists of products and services and most companies in New Zealand prefer to use the Internet as a means of providing information to customers and suppliers [15].

The New Zealand online fashion industry, although still in its infancy, is very much alive and will grow rapidly over the next few years [9]. This growth will result from the combination of an increasingly large number of online consumers and the growing number of fashion web sites. In evaluating the Internet as a fashion retail channel, a number of advantages added to the retailer have been identified by different scholars. These include direct communication with customers, access to a wider audience, cost savings and product selling available to consumers all the time [8] [6] [7] [13]. Additional advantages added to the online consumers include in-depth product information, two-way communication, demonstration of products in real time and up-to-date online information [14] [13].

A survey by Greenfield Online found that 58 percent of respondents shopped online to avoid crowded offline stores and 57 said Internet shopping saves time [1]. Availability of products/services, as in access to variety, the ability to scan more products and compare prices are significant reasons for shopping online [2].

III. Research Methodology

The main purpose of this research is to evaluate the performance of New Zealand fashion web sites and thereby to gain an understanding of how New Zealand fashion web sites can improve. As online content is expanding, there is an increasing need to control and manage the quality of the web

site content. Fashion web sites continue to grow in complexity, placing additional challenges for web designers. For fashion organisations that want to be online, meeting customer expectations is critical. Customers require timely, accurate information. Content analysis was used to assess and rank fashion web sites capabilities against the proposed model that serves as a benchmark. In this study, web site content analysis is carried out to measure the effectiveness of selected New Zealand fashion web sites. In order to gather appropriate dimensions and related attributes, we developed a tailored web site evaluation model to specifically analyse New Zealand fashion web sites adopting Ian Hersey's model (cited in [18]). Table 1 listed the categories and their related elements that are used to evaluate the fashion sites. They are in four categories namely Information, Transaction Service, Trust, and Non-Functional requirements. Table 1 has also listed the related elements that will be tested for appearance.

Information Category	Transaction Service Category	Trust Category	Non-Functional Requirements Category
Company Information Consumer Information Product Information	Negotiation	Legal Disclaimer	Aesthetic effect
	Payment	Privacy statement	Ease of use
	Order	Security	Innovation
	Delivery		Community
	After-sale service		
	Help		

Table 1: Categories & Elements of the Tailored Web Site Evaluation Model

IV. Results

Content analysis was conducted based on the tailored web site evaluation model. The sample fashion sites were evaluated by assigning a 0 or 1 score based on the presence or absence of the elements at the web site. A "1" score is assigned if the element is present or "0" score is assigned if the element is absent at the site. Forty New Zealand fashion web sites were selected for content analysis. Table 2 below presents the scores of the top twelve New Zealand fashion web sites.

The average score of all the 40 fashion sites is 14.8 out of 25 (59%), the median total score is 17 out of 25 (68%). With a possible total score of 25, a score of at least 12.5 (i.e. 50%) represents the elements required in order to achieve a 'pass'. 60% of the sample web sites scored more than 50%. These figures reflect a moderately high adoption of elements in the tailored web site evaluation model by the sampled New Zealand fashion web sites. 58% of the sample web sites are positioned as full e-commerce capability sites. Some of the high scoring sites are large organisations and some of the low scoring sites are large organisations too. That is, there is no relationship between a good web site and the size of the

organisations.

Rank	NZ Fashion Web Site	I	TS	T	NF	Total
1	Canterbury of New Zealand	7	10	3	3	23
1	Thread	7	9	3	4	23
2	Beggs Clothing	7	10	3	2	22
2	Ezibuy NZ Ltd.	7	10	3	2	22
2	Pumpkin Patch	7	10	3	2	22
2	NZ Pacific Jewellery, Skincare & Clothing	7	10	3	2	22
2	Christies Jewellery	7	9	2	4	22
3	Line 7	6	10	3	2	21
4	Shirleys Shoes	6	10	2	2	20
4	Sunsational Swimwear	6	10	2	2	20
4	Susanna Bernard	5	10	3	2	20
5	Fashion Factory	6	10	1	2	19

Table 2: Top 5 Scored New Zealand fashion web sites

V. Discussion

The majority of New Zealand fashion web sites are informational rather than transactional. This is consistent with the literature that most companies in New Zealand prefer to use the Internet as a means of providing information to customers, rather than for online sales [15].

After examining the forty sample New Zealand fashion web sites, we found that 58% of the web sites are positioned as full e-commerce capability sites. This closely matches previous similar research done by Paynter, Satikit and Chung (cited in [12]). Content analysis results show that the overall performance of the sample fashion web sites in the information category is relatively high with an average total score of 72% in this category. The results support the view that fashion organisations are utilising the Internet mainly as a platform for information distribution or product promotion rather than electronic retailing. Almost all of the sample fashion web sites provide information on the company's background, physical address and contact details. This is not a surprising result since consumers want to know with whom they are dealing and this is especially important for new virtual fashion organisations solely operating on the Internet. A very similar result was found in research by Paynter et al. (2001), where 74% of New Zealand e-tailing sites provided informational rather than transactional capability. Three of the thirty e-tailing sites examined were fashion ones, namely Pumpkin Patch, Farmers and Ezibuy. The average total score of the three fashion web sites in their study is 71.2% and the average total score of all thirty e-tailing web sites in their study is 70.2%. The content analysis results from our tailored web site evaluation model reveals that the average total score of all the forty sample fashion sites is 59% and the median total score is 68% which closely matches with previous similar research. Although pleasing results were found in the information category, New Zealand fashion web sites need to be more concerned in the trust and non-functional requirements category. Given the low average score (39%) in the trust category, fashion web sites did poorly in addressing privacy, security and legal (disclaimer) issues. The majority of fashion web sites asked

consumers for their personal information, this is consistent with previous research by Chung (cited in [3]) that 80% of New Zealand fashion web sites collected personal data and only small numbers of fashion sites provided a privacy statement. Consumers want to be connected to the Internet for a unique experience and they expect an interactive linkage to the Internet [11]. With an average score of 47% in the non-functional requirements category, New Zealand fashion web sites did not perform very well in this category. Although all of the fashion web sites performed very well in the aesthetic effect and ease of use elements, only a few fashion web sites implement advanced innovative features, online community and have entertainment value.

VI. Conclusion

The use of the Internet for the glamorous fashion industry has generated great excitement because it allows up-to-the minute information delivery, allowing the industry to broaden its market. Content analysis of the web sites of 40 New Zealand fashion organisations revealed their information, transactional service, trust and non-functional requirements. Content analysis looks at the components of the web sites and how they are used by the organisations to enhance their business. The result implies that there is a moderately high adoption of elements in the tailored web site evaluation model by the sample New Zealand fashion web sites. There is no relationship between a good fashion web site and the size of an organisation as we found in the results of content analysis. Fashion organisations are utilising the Internet mainly as a platform for information distribution or product promotion rather than electronic retailing.

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Competitive Strategies for On-Line Advertisement-Place Auction

Zhang E

Shanghai University of Finance and Economics, Shanghai, China, 200433

Email: eezhangee@hotmail.com

Abstract: For the online problem of Internet Search Engines' Keyword Advertisement-place auction, two online models are present in this paper. The number of the auction phases is known or unknown beforehand respectively in the two models. For the first model we propose the Multi-Level of Accepted Price Strategy (abbr. MLAP) and prove it to be $O(\Phi^{1/4})$ -competitive, where Φ is the ratio of the highest bid to the lowest one in the auction. For the second model a strategy similar to the first one (abbr. MLAP1) is put forward and proved to be $(2\sqrt{\Phi} - 1)$ -competitive. Furthermore, the experimental results show that in both models the experimental ratios between what the optimal strategy and the online strategies gain are much better than the theoretical ones, indicating that the two strategies perform much better in practice than in theory. In practice, these strategies may help to realize the automatic auction of heterogeneous objects that have similar traits to advertisement-places.

Keywords: Advertisement-Place Auction;
Online Strategy; Competitive Ratio.

I. Introduction

Since 1993, the advertisement-place auction has brought Chinese CCTV great revenue each year. On Nov. 18, 2004, it obtained a revenue of 5.482 billion yuan by auctioning some golden period advertisement-places of year 2005. Recently many Internet Content Providers (Abbr. ICP) adopt to price their advertisement-place by auction gradually [1]. In an auction, the highest bid wins the first advertisement-place, the second highest bid wins the second place, and so on. This is a kind of heterogeneous object auction in which each bidder demands one unit of object.

In benchmark auction model, the auctioneer auctions one object and each bidder demands one. The auctioneer designs an auction mechanism to maximize his revenue. In the online model, however, we use the competitive ratio to gauge the efficiency of an online strategy or mechanism. The competitive ratio is equals to the revenue

obtained by the optimal offline strategy to that by the online strategy [2].

There are lots of literature on online auction. Ziv Bar-Yossef et al. [3] presented an online model of digital object auction and studied the competitiveness of an online strategy in the condition of compatibility. They gave a $O(e^{\sqrt{\log \log h}})$ -competitive randomized strategy where h is the ratio between the highest and the lowest estimated values by bidders. Avrim Blum et al. [4] studied a digital multi-object online model. A randomized online learning strategy, called WM, was given and proved to be $O(e^{\sqrt{\log \log h}})$ -competitive. Both Ziv Bar-Yossef and Avrim Blum assumed that the estimated values of all the objects is in $[1, h]$ and each bidder can only select one of the l bids. That is, the bid is discrete. Thus, an interesting question is what the competitive ratio will be if a bid may be an arbitrary value in $[1, h]$. In this paper we will focus on the continuous case of bid price.

The rest of this paper is organized as follows. Section 2 discusses the first model where the auctioneer knows the number of auction phases at the beginning of the auction. An effective strategy is put out and proved to be $O(\Phi^{1/4})$ -competitive. The second model of unknown the number of auction phases at the beginning is analyzed in section 3, and a competitive strategy is proposed. In section 4 some simulation results of the two strategies are presented. Finally, section 5 concludes this paper.

II. The Number of the Auction Phases Is Known Beforehand

II.1 Model Description

In this section we will discuss the case that the auctioneer know the number of bidders or the auction phases at the beginning. For expressional convenience, we call advertisement places heterogeneous objects. We first give the following four assumptions.

a) There are totally $m(\geq 2)$ heterogeneous objects. The price of each bid is in $[\underline{v}, \bar{v}]$ satisfying $\frac{\bar{v}}{\underline{v}} = \Phi$. The above information is the common knowledge.

b) The auctioneer obtains no value from a heterogeneous object if he keeps it. That is, the auctioneer gets a profit from the object only when it is sold successfully.

c) There are n bidders in the auction, only one of which arrives and bids at each phase. Denote by $\sigma = \{b_1, \dots, b_n\}$ the whole auction process where b_i is the bid of bidder i ($1 \leq i \leq n$). n is known by the auctioneer beforehand.

d) The auctioneer must decide whether to accept bid b_i on its arrival since b_i will leave the system if it has not been accepted before the arrival of the next bid.

By the assumption b), the auctioneer shall try to sell as many heterogeneous objects as possible, and for each object the price shall be as high as possible. The objective is to maximize the total revenue of accepted bids. More precisely, $\max \sum_{j=1}^m p_j$ where $p_j \in [\underline{v}, \bar{v}] \cup \{0\}$ is the accepted price for the j th heterogeneous object. $p_j = 0$ if the auctioneer keeps the j th object.

II.2 The Multi-Level of Accepted Price Strategy

According to the model given above, when a bid arrives, the auctioneer decides whether to accept the bid but not to assign an object to the bid immediately. The auctioneer also knows n and $[\underline{v}, \bar{v}]$ at the beginning of the auction. Thus, we give an effective strategy called Multi-Level of Accepted Price (Abbr. MLAP). The main idea of MLAP is to divide the bidding support $[\underline{v}, \bar{v}]$ into several sub-supports and accept a fixed number of bids in each sub-support.

MLAP is described as follows. Assume that there are w bids accepted at the beginning of the i th phase. If $n - i < m - w$, that is, the number of the rest phases is less than the number of acceptable bids, MLAP accepts all the bids arriving, including b_i . Otherwise, MLAP accepts x bids satisfying

$$\alpha \underline{v} \leq b_i < \sqrt{\phi} \underline{v}, \quad (1)$$

y bids satisfying

$$\sqrt{\phi} \underline{v} \leq b_i < \beta \underline{v}, \quad (2)$$

z bids satisfying

$$\beta \underline{v} \leq b_i < \phi \underline{v}, \quad (3)$$

and $(m - x - y - z)$ bids satisfying

$$b_i = \phi \underline{v} = \bar{v}, \quad (4)$$

respectively, where x, y, z $1 \leq \alpha < \sqrt{\Phi}$ and $\sqrt{\Phi} \leq \beta < \Phi$ are some positive constants determined later. The total number of accepted bids is at most m . In special, if b_i satisfies (4) and MLAP has accepted $(m - x - y - z)$ bids satisfying (4), then MLAP will accept b_i if only the total number of accepted bids is less than m . Similarly, if b_i satisfies (3) and MLAP has accepted $(m - x - y - z)$ bids satisfying (4) and z bids satisfying (3), then MLAP will accept b_i if only the total number of accepted bids is less than m . If b_i satisfies (2) and MLAP has accepted y

bids satisfying (2) but less than x bids satisfying (1), then MLAP will accept b_i and count the number of accepted bids by (1) plus 1.

II.3 Competitive Analysis

In this section we will analyze the competitiveness of MLAP. We first give the following theorem and the rest of this section is contributed to the proof of the theorem.

Theorem 1 *MLAP is $O(\Phi^{1/4})$ -competitive.*

Proof. We utilize the adversary strategy and worst case analysis to prove the theorem. Assume that an adversary always tries to design the worst bid input sequence to make MLAP behave worst, making the optimal strategy OPT obtain the most revenue and MLAP obtain the least. More precisely, the adversary will make MLAP accept the lowest bids as many as possible and OPT accept the highest bids as many as possible. For the whole auction process $\sigma = \{b_1, \dots, b_n\}$, denote by $M(\sigma)$ and $O(\sigma)$ the total revenues obtained by MLAP and OPT respectively. According to the construction of MLAP, there are four possible bid input worst cases.

Case 1. The highest bid in σ is less than $\alpha \underline{v}$. The adversary try to make MLAP accept the lowest bids as many as possible and to make OPT accept bids with value a little less than $\alpha \underline{v}$. In the first $n - m$ phases, all the bids equal $\alpha \underline{v} - \epsilon$ ($\epsilon \rightarrow 0^+$), and the rest m bids equal \underline{v} . OPT will accept m bids with value $\alpha \underline{v} - \epsilon$ but MLAP will accept the last m bids with value \underline{v} for all the bids do not satisfy the inequalities in the construction of MLAP. Thus, in this case the ratio of what OPT obtains to what MLAP obtains equals $\frac{O(\sigma)}{M(\sigma)} = \frac{m(\alpha \underline{v} - \epsilon)}{m \underline{v}} < \alpha$.

Case 2. The highest bid in σ is less than $\sqrt{\Phi} \underline{v}$. The adversary releases the first x bids with value $\alpha \underline{v}$, the following m bids with value $\sqrt{\Phi} \underline{v} - \epsilon$ and the last $n - x - m$ bids with value \underline{v} . MLAP will accept the first x bids and the last $m - x$ bids due to the construction of MLAP. However, OPT will accept the m bids with value $\sqrt{\Phi} \underline{v} - \epsilon$. Thus, in this case the ratio between what OPT and MLAP obtain equals $\frac{O(\sigma)}{M(\sigma)} = \frac{m(\sqrt{\Phi} \underline{v} - \epsilon)}{x \alpha \underline{v} + (m - x) \underline{v}} < \frac{m \sqrt{\Phi}}{x \alpha + m - x}$. Let $\frac{m \sqrt{\Phi}}{x \alpha + m - x} = \alpha$. We have that

$$x = \frac{(\sqrt{\Phi} - \alpha)m}{(\alpha - 1)\alpha}. \quad (5)$$

Thus, if the above equation holds the ratio between what OPT and MLAP obtain is at most α in this case.

Case 3. The highest bid in σ is less than $\beta \underline{v}$. The adversary releases the first x bids with value $\alpha \underline{v}$, the following y bids with value $\sqrt{\Phi} \underline{v}$ and then m bids with value $\beta \underline{v} - \epsilon$, and the last $n - x - y - m$ bids with value \underline{v} . MLAP will accept the first $x + y$ bids and the last

$m-x-y$ bids due to the construction of MLAP. However, OPT will accept the m bids with value $\beta\bar{v} - \epsilon$. Thus, in this case the ratio between what OPT and MLAP obtain equals $\frac{O(\sigma)}{M(\sigma)} = \frac{m(\beta\bar{v}-\epsilon)}{x\alpha\bar{v}+y\sqrt{\Phi}\bar{v}+(m-x-y)\bar{v}} < \frac{m\beta}{x\alpha+y\sqrt{\Phi}+m-x-y}$. Let $\alpha = \frac{m\beta}{x\alpha+y\sqrt{\Phi}+m-x-y}$. Together with equation (5), we have that

$$y = \frac{(\beta - \sqrt{\Phi})m}{(\sqrt{\Phi} - 1)\alpha}. \quad (6)$$

Thus, if equations (5,6) hold the ratio between what OPT and MLAP obtain is at most α in this case.

Case 4. The highest bid in σ is less than \bar{v} . The adversary releases the first x bids with value $\alpha\bar{v}$, the following y bids with value $\sqrt{\Phi}\bar{v}$ and z bids with value $\beta\bar{v}$, and then m bids with value $\bar{v} - \epsilon$, and the last $n - x - y - z - m$ bids with value \bar{v} . MLAP will accept the first $x + y + z$ bids and the last $m - x - y - z$ bids due to the construction of MLAP. However, OPT will accept the m bids with value $\bar{v} - \epsilon$. Thus, in this case the ratio between what OPT and MLAP obtain equals $\frac{O(\sigma)}{M(\sigma)} = \frac{m(\bar{v}-\epsilon)}{x\alpha\bar{v}+y\sqrt{\Phi}\bar{v}+z\beta\bar{v}+(m-x-y-z)\bar{v}} < \frac{m\Phi}{x\alpha+y\sqrt{\Phi}+\beta z+m-x-y}$. Let $\frac{m\Phi}{x\alpha+y\sqrt{\Phi}+\beta z+m-x-y} = \alpha$. Together with equations (5) and (6), we have that

$$z = \frac{(\Phi - \beta)m}{(\beta - 1)\alpha}. \quad (7)$$

Thus, if equations (5,6,7) hold the ratio between what OPT and MLAP obtain is at most α in this case.

Based on the above argument, if x, y and z satisfy the equations (5,6,7) respectively and inequality $x + y + z \leq m$, MLAP is α -competitive. Combining $x + y + z \leq m$ with equations (5,6,7), we have that

$$\frac{(\sqrt{\Phi} - \alpha)m}{(\alpha - 1)\alpha} + \frac{(\beta - \sqrt{\Phi})m}{(\sqrt{\Phi} - 1)\alpha} + \frac{(\Phi - \beta)m}{(\beta - 1)\alpha} \leq m. \quad (8)$$

The rest problem is to judge the existence of such an α that inequality (8) holds and $1 \leq \alpha \leq \sqrt{\Phi}$. Let $B = \frac{(\beta - \sqrt{\Phi})}{(\sqrt{\Phi} - 1)} + \frac{(\Phi - \beta)}{(\beta - 1)}$, inequality (8) turns out to be $\alpha^2 - \alpha B + B - \sqrt{\Phi} \geq 0$. Solving the inequality we have that $\alpha \leq \frac{B - \sqrt{B^2 - 4(B - \sqrt{\Phi})}}{2}$ or $\alpha \geq \frac{B + \sqrt{B^2 - 4(B - \sqrt{\Phi})}}{2}$. The solution $\alpha \leq \frac{B - \sqrt{B^2 - 4(B - \sqrt{\Phi})}}{2}$ is deleted since it does not satisfy $\alpha \geq 1$. Thus, $\alpha \geq \frac{B + \sqrt{B^2 - 4(B - \sqrt{\Phi})}}{2}$. Since the competitive ratio is an increasing function of α , when $\alpha = \frac{B + \sqrt{B^2 - 4(B - \sqrt{\Phi})}}{2}$, MLAP reaches the optimal competitive ratio. Let $F(\beta) = \frac{B + \sqrt{B^2 - 4(B - \sqrt{\Phi})}}{2}$. Taking the differential of β and equating it with zero, we get that $B' = 0$ or $-1 = \frac{B-2}{\sqrt{B^2 - 4(B - \sqrt{\Phi})}}$. The latter solution is deleted for $\Phi \geq 1$. By $B' = 0$, together with the definition of B , we

have that $\beta = 1 + (\sqrt{\Phi} - 1)\sqrt{\sqrt{\Phi} + 1}$ and then $B = 2\sqrt{\sqrt{\Phi} + 1} - 2$. Thus, $\alpha = \frac{B + \sqrt{B^2 - 4(B - \sqrt{\Phi})}}{2} = (\sqrt{2} + 1)(\sqrt{\sqrt{\Phi} + 1} - 1)$ and MLAP is $O(\Phi^{1/4})$ -competitive. The relevant values of x, y and z can be obtained by equations (5), (6) and (7). We complete the proof.

III. The Number of the Auction Phases Is Unknown Beforehand

III.1 Model Description

In this section we will discuss the case that the auctioneer does not know the number of the auction phases at the beginning. The assumptions of this model are basically the same as those of the previous model. The only difference lies in assumption c) where the auctioneer does not know n beforehand in this model. The objective is to maximize the total revenue of accepted bids.

III.2 The Multi-Level of Accepted Price-1 Strategy

Since the auctioneer does not know when the auction activity will end, we give an effective strategy called Multi-Level of Accepted Price-1 (Abbr. MLAP1). The main idea of MLAP1 is that no matter at which phase the auction ends, MLAP1 ensures that what it has obtained is at least a fixed factor of what OPT has obtained.

MLAP1 is described as follows. MLAP1 accepts $\frac{m}{\alpha}$ bids in $[\underline{v}, \sqrt{\Phi}\underline{v}]$, $\frac{(1-1/\sqrt{\Phi})m}{\alpha}$ bids in $[\sqrt{\Phi}\underline{v}, \bar{v})$ and $\frac{[a-(2-1/\sqrt{\Phi})]m}{\alpha}$ bids with value \bar{v} respectively. The total number of accepted bids is at most m . In special, if MLAP1 has accepted $\frac{(1-1/\sqrt{\Phi})m}{\alpha}$ bids in $[\sqrt{\Phi}\underline{v}, \bar{v})$ but less than $\frac{m}{\alpha}$ bids in $[\underline{v}, \sqrt{\Phi}\underline{v}]$, then a new bid with value in $[\sqrt{\Phi}\underline{v}, \bar{v})$ will be accepted and count the number of the total accepted bids plus 1. Similarly, if MLAP1 has accepted $\frac{[a-(2-1/\sqrt{\Phi})]m}{\alpha}$ bids with value \bar{v} but less than $\frac{(1-1/\sqrt{\Phi})m}{\alpha}$ bids in $[\sqrt{\Phi}\underline{v}, \bar{v})$ or $\frac{m}{\alpha}$ bids in $[\underline{v}, \sqrt{\Phi}\underline{v}]$, then a new bid with value in $[\sqrt{\Phi}\underline{v}, \bar{v})$ or $[\underline{v}, \sqrt{\Phi}\underline{v}]$ will be accepted and count the number of the total accepted bids plus 1.

III.3 Competitive Analysis

In this section we will analyze the competitiveness of MLAP1. We give the following theorem and the rest of this section is contributed to the proof of the theorem.

Theorem 2 *MLAP1 is $(2\sqrt{\Phi} - 1)$ -competitive.*

Proof. The proof idea is similar to that of MLAP. For the whole auction process $\sigma = \{b_1, \dots, b_n\}$, denote by $M1(\sigma)$ and $O(\sigma)$ the total revenues obtained by MLAP1

and OPT respectively. There are two possible worst cases for MLAP1.

Case 1. The highest bid is less than $\sqrt{\Phi}v$. The adversary will release the first $\frac{m}{\alpha}$ bids with value v and the following m bids with value $(\sqrt{\Phi} - \epsilon)v$ and no more bid arrives. In this case, MLAP1 will only accept the first $\frac{m}{\alpha}$ bids and reject the following m bids due to its construction. OPT will accept the m bids with value $(\sqrt{\Phi} - \epsilon)v$. Thus, the ratio between what OPT and MLAP1 obtain equals $\frac{O(\sigma)}{M1(\sigma)} = \frac{(\sqrt{\Phi} - \epsilon)vm}{(m/\alpha)v} < \alpha\sqrt{\Phi}$.

Case 2. The highest bid is less than $\Phi v = \bar{v}$. The adversary will release the first $\frac{m}{\alpha}$ bids with value v and the following $\frac{(1-1/\sqrt{\Phi})m}{\alpha}$ bids with value $\sqrt{\Phi}v$, and m bids with value $(\Phi - \epsilon)v$ and no more bid arrives. In this case, MLAP1 will only accept the first $\frac{(2-1/\sqrt{\Phi})m}{\alpha}$ bids and reject the following m bids due to its construction. OPT will accept the m bids with value $(\Phi - \epsilon)v$. Thus, the ratio between what OPT and MLAP1 obtain equals $\frac{O(\sigma)}{M1(\sigma)} = \frac{(\Phi - \epsilon)vm}{(m/\alpha)v + \frac{(1-1/\sqrt{\Phi})m}{\alpha}\sqrt{\Phi}v} < \frac{\alpha\Phi}{1+(1-1/\sqrt{\Phi})\sqrt{\Phi}} = \alpha\sqrt{\Phi}$.

Based on the analysis of the above two cases, MLAP1 is $\alpha\sqrt{\Phi}$ -competitive. Moreover, the total accepted bids shall be no more than m , that is, $\frac{m}{\alpha} + \frac{(1-1/\sqrt{\Phi})m}{\alpha} \leq m$. Solving the inequality we have that $\alpha \geq 2 - 1/\sqrt{\Phi}$. Since the competitive ratio is an increasing function of α . Let $\alpha = 2 - 1/\sqrt{\Phi}$, then MLAP1 is $(2\sqrt{\Phi} - 1)$ -competitive. Hence, the proof is completed.

IV. Experiment

In the previous two sections we proposed two effective strategies for two models respectively and proved their competitiveness theoretically. In this section we will give some simulations and compare the experimental results to the theoretical ones.

The following is the simulation for both models. The original data are from www.baidu.com website. There are 83 bids for the keyword "Flower" on Feb. 12, 2005. The highest bid is 6.75 yuan and the lowest one is 0.3 yuan. Thus, for the model of knowing the auction phases beforehand, the bid phases $n = 83$ and the ratio between the highest bid and the lowest one $\Phi = 22.5$. The theoretical value of the competitive ratio of MLAP can be obtained by Theorem 1, equaling $(\sqrt{2} + 1)(\sqrt{\sqrt{\Phi} + 1} - 1) = 3.37$. On the other hand, in the experiment, the bid arrival sequence is equal to the data list in the website. some of the experiment results by MLAP are shown in form 1. $m = 20, 30, 40$ are the numbers of heterogeneous objects. For each m , the x, y, z values are figured out by equations (5), (6) and (7). We can see that the highest value of the competitive ratio equals 1.96 in the form, which is much less than the theoretical value. The reason is that the theo-

retical result is proved by worst case analysis. However, in practice, the worst case rarely happens.

Form 1 Some simulation results of the first model.

σ	$m=20$			$m=30$			$m=40$		
Assigned-values σ	$x, y, z=4, 8, 8$			$x, y, z=6, 12, 12$			$x, y, z=7, 17, 26$		
Online Revenue σ	90.11 σ	79.28 σ	64.65 σ	125.55 σ	118.33 σ	98.89 σ	168.37 σ	156.56 σ	109.37 σ
Optimal Revenue σ	124.74 σ	155.3 σ	91.66 σ	160.05 σ	123.24 σ	109.95 σ	182.24 σ	174.49 σ	120.04 σ
Competitive ratio σ	1.38 σ	1.96 σ	1.42 σ	1.27 σ	1.04 σ	1.11 σ	1.08 σ	1.11 σ	1.1 σ

Form 2 Some simulation results of the second model.

σ	$m = 20$				$m = 40$			
n	Online Revenue σ	Offline Revenue σ	E-ratio σ	T-ratio σ	Online Revenue σ	Offline Revenue σ	E-ratio σ	T-ratio σ
50 σ	43.01 σ	93.1 σ	2.16 σ	4.89 σ	81.84 σ	114.23 σ	1.40 σ	5.02 σ
17 σ	38.05 σ	53.55 σ	1.41 σ	4.81 σ	38.05 σ	53.55 σ	1.41 σ	5.53 σ
73 σ	43.01 σ	113.36 σ	2.64 σ	6.24 σ	81.84 σ	155 σ	1.89 σ	7.37 σ
32 σ	43.01 σ	73.25 σ	1.70 σ	4.62 σ	64.58 σ	78.08 σ	1.21 σ	4.98 σ
42 σ	43.01 σ	88 σ	2.05 σ	4.25 σ	81.54 σ	101.9 σ	1.25 σ	5.31 σ
31 σ	43.01 σ	71.48 σ	1.66 σ	4.02 σ	62.06 σ	75.56 σ	1.22 σ	4.35 σ
46 σ	43.01 σ	92.73 σ	2.16 σ	4.98 σ	81.84 σ	109.97 σ	1.34 σ	4.58 σ
51 σ	43.01 σ	55.01 σ	1.28 σ	5.54 σ	81.84 σ	100.87 σ	1.23 σ	6.02 σ
55 σ	43.01 σ	97.33 σ	2.26 σ	5.31 σ	81.84 σ	120.44 σ	1.47 σ	6.47 σ

For the model of unknowing the auction phases beforehand, the original data are the same as those of the previous model. The number of auction phases n are produced randomized in [1, 83]. For each n , we randomly select n numbers from the 83 bids, and the bid arrival sequence is randomized produced by the n bids. For each experiment, the relevant theoretical competitive ratio can be figured out by the n bids and Theorem 2, as shown in Form 2 below T-ratio. We set $m = 20, 40$ and obtain the experiment results by MLAP1. The optimal revenue, MLAP1 revenue and the competitive ratio below E-ratio in the experiment are shown in Form 2. Obviously, all the values below E-ratio are much less than those below T-ratio. The reason is the same as that of the previous model.

V. Conclusion

In this paper we analyze the online problem of network advertisement-place auction. We present two online models where the number of auction phases are known or unknown beforehand respectively. Two deterministic strategies are proposed and proved to be $O(\Phi^{1/4})$ and $(2\sqrt{\Phi} - 1)$ -competitive respectively where Φ is the ratio between the highest and the lowest bids in the auction. In practice, these strategies may help to realize the automatic auction of heterogeneous objects that have similar traits to advertisement-places. There are still

some problems that can be further analyzed. For example, whether there exist better deterministic strategies for the two models or what is the lower bound of deterministic strategies? Moreover, if a bidder can submit a vector of bids for different objects, then whether there exists an efficient strategy for this case?

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Business Strategies For the New Zealand Online Fashion Industry

Winnie Wing Man Hui, John Paynter
Department of Information Systems & Operations Management
University of Auckland
Private Bag 92019, Auckland, New Zealand.
E-mail: winniewingman@gmail.com; j.paynter@auckland.ac.nz

Abstract: The popularity of the Internet has raised the number of people shopping online and offers opportunities for fashion businesses to promote or sell their products via the Internet. There are an increasing number of New Zealand fashion organisations launching a web site either for information distribution, promotional use or online retailing. It is believed that the online fashion industry has a tremendous potential in New Zealand. Four interviews were carried out within New Zealand fashion organisations with the focus being their tactics in creating Internet fashion sites and the determinants to make them successful ones. A successful fashion web site should have rich and high quality content, fast loading speed, easy for navigation and good graphics. It is important for New Zealand fashion organisations to frequently update their web site, offer new promotions, consider consumer preferences and improve from there.

Keywords: E-Commerce Management, Internet Marketing.

I. Introduction

New Zealand's small size, geographic isolation and technologically-aware population have all contributed to the widespread and rapid uptake of Information Technology [14]. New Zealand has a small domestic market and a high degree of technology adoption when compared to the rest of the developed countries [17]. Due to the unique ability of the Internet to attract customers in an efficient and timely manner, it offers consumers an additional channel for information and purchasing, as well as increased choice, convenience, competition among retailers, and cost savings. With technology advancing everyday, "the Internet will help create and promote many new innovations for the fashion industry" [18]. Fashion is a fast growing, creative, interesting and time-sensitive industry. Many fashion retailers have developed a web presence to compete in this fast-paced industry. The fashion industry is seasonal and trend-based and its products have a limited life span. Bell [4] also indicates that the fashion industry moves at a frenetic pace where new designs are frequently introduced, so rapid electronic distribution of information is highly desirable. Using the Internet, fashion companies can deliver up-to-date information to consumers in a cost-effective way,

communicate with customers and promote the brand name in an easier way. Apparel products have become the third largest retail sales category on the Internet [7]. Since fashion purchases represent a significant portion of online purchasing [7], the potential of the online fashion industry is enormous. Fashion web sites seek to develop effective strategies based on knowledge of their consumers [10]. This research may help online fashion marketers improve their strategies designed to entice customers to shop online.

II. Literature Review

There are many reasons why people like to shop online. According to Bhatnagar, Misra and Rao [5], convenience and saving time were cited as the top two reasons to shop online, where shopping from home can avoid hassles of parking, salespeople and checkout lines. A survey by Greenfield Online found that 58 percent of respondents shopped online to avoid crowded offline stores and 57 said Internet shopping saves time [1]. Availability of products/services, as in access to variety, the ability to scan more products and compare prices are significant reasons for shopping online [2].

While Internet technology enables the convenience of online shopping, it has shortcomings. According to Lee and Johnson [12], most Internet users purchased non-apparel items (for example, CDs, books, software) and only 12 percent of the users had purchased apparel and apparel-related items. Customers cannot physically examine, touch and test products or get hands on help when shopping online. Forsythe, Kim & Petee [9] also identified seven major barriers to online shopping. These include credit card security concerns, privacy concerns, lack of web site credibility, inability to judge quality, no real-time interaction opportunities, site navigation concerns and lack of loyalty.

Despite the rosy growth predictions, online fashion retailing still encounters numerous challenges. Buying clothing, footwear, jewellery and accessories online involves far more subjectivity than shopping online for products like books, software or electronics. A number of recent studies identified the causes for consumer hesitancy to buy fashion online. According to Rodriguez [15], the biggest hurdle is the customers' demand to simulate on the Internet the see, feel and touch experience when buying clothes. Customers want to know if the selected item fits them well and whether they would look good in those clothes. NPD Group found that 85% of online consumers were reluctant to shop for clothes online because they cannot try on the items. Beck [3]

states that even though the online apparel market has exciting growth, high product return rates persist and most consumers are still either hesitant to purchase apparel online or are dissatisfied with their online shopping experience.

The demographic profile for Internet shoppers are constantly changing, Ernst & Young conducted a study which revealed that the typical online purchaser was well educated, married, and had a high economic status [19]. Skelly [16] estimates that women spend about three times as much as men on the purchase of clothing online. Consumer's age influences online buying decisions. As people became mature, they learn more about the products in the marketplace through experience and form more confident opinions about what suits their likes and what does not [5]. We conducted in-depth interviews with representatives of New Zealand fashion organisations in order to explore the business strategies used by New Zealand fashion organisations in creating their web sites.

III. Research Methodology

In this study, the main purpose of the interviews was to capture an in-depth understanding of online fashion organisations' operations from the perspective of the online fashion organisation representatives. The interview "is a dynamic vehicle for exploring the rich and complex body of information possessed by an individual" [6]. The criteria for selected subjects were based on subjects must have had experience and have had knowledge of the New Zealand online fashion industry. Four representatives of fashion organisations agreed to participate in this study. The four subjects were chosen for their extensive knowledge and experience of the New Zealand online fashion industry.

Two of the interviews were conducted face-to-face. According to Cavana, Delahaye and Sekaran [6], the main advantage of face-to-face interviews is that the researcher can adapt the questions as necessary, clarify doubts and ensure that responses are properly understood by repeating or rephrasing the questions. Two of the interviews were conducted via e-mail format at the request of the interviewees. Mann & Stewart [13] said that e-mail interviews are a practical way to collect information from individuals who are geographically distant.

A preliminary information gathering stage was carried out before conducting the interviews. The four fashion organisations' web sites were observed and the organisations' background information was examined. The four structured interviews were conducted with a list of predetermined, standardised open-ended questions which are carefully ordered and worded in a detailed interview schedule. Some changes to questions were made in order to suit the circumstances of different organisations. The questions were pre-planned and cover topics on business operations, web site development strategies, current situation and future development of New Zealand online fashion industry.

IV. Results & Discussion

Electronic Commerce represents a new medium and a different means of delivering product. For the fashion retailers, the Internet does not change the nature of the product itself. Fashion e-retailers can learn from direct marketers because they have existing successful business strategies. Most New Zealand fashion organisations understand the benefits of using the Internet as a promotion/product or information distribution channel. The benefits of using the Internet specified by the organisations include brand awareness, international reach, a means to update information for consumers, more cost effectively than traditional promotion methods and gives them a shop window that opens 24 hours 7 days. One interviewee emphasised that the only way that New Zealand fashion organisations can compete both locally and internationally is by good web site design.

The important web site features as cited by organisations are: high quality images, fast loading speed, easy navigation and usability, provide e-newsletter, real live fashion show, fashion report, online communities and competitions for consumer to enter. New Zealand fashion organisations use banner advertisements, major search engines and directories and word of mouth to advertise and attract consumers to their sites.

All of the interviewees emphasised that their main target audiences are women as men are not interested as much as women in fashion. One of the interviewee asserted that women are major influences in buying men's fashion. Forsythe, Kim and Petee [9] also suggested that women are the primary purchasers of fashion products in traditional retail environments, so there is a need for fashion organisations to understand the online decision-making process among women to enhance online fashion purchases.

Fashion organisations need to have a long term, formal, strategic plan for their web site development. Most of the fashion organisations mentioned that they have achieved this. All of the interviewed organisations believed that the New Zealand online fashion industry will continue to grow and there are many opportunities to introduce New Zealand fashion to the world by using the Internet. The main problems as cited by organisations, were getting an income stream, the high cost to maintain the web site, consumer fears to buy fashion products online and security issues. One major challenge of Internet companies was they are struggling to reach profitability [8]. It is difficult for fashion organisations to get an income stream that will support the functionality and the quality of content and design. It is hard to get consumers to pay for online information, and the costs associated with maintenance of the web site are high. One interviewee stated that their web site currently does not post a profit, so they have added a print magazine. Another key barrier that discouraged people from buying fashion products online is the lack of feel and touch for the fashion products before they purchase. One of the top reasons that consumers mentioned for not purchasing fashion products

online was because of questions about fit. Some of the consumers prefer to try on the fashion products before making a purchase. For example, when buying clothes, consumers want to know if the selected product fits them well and whether they would look good in those clothes. Research also indicates that the majority of New Zealand fashion web sites are informational rather than transactional [11]. As New Zealand is a small country, it is all too easy for consumers to drive to a store and try on garments. Therefore it is difficult for fashion stores to sell online. The likelihood of a consumer purchasing a fashion product goes down as their perception of risk goes up.

The future of New Zealand fashion industry looks bright. It is predicted that all of the fashion organisations need a web presence in the future either for information distribution, promotion, e-retailing or to develop a loyal online community. The rapid growth of the Internet will lower the technological costs associated with establishing or maintaining a web site. As the entry cost to go online gets cheaper, more fashion organisations will launch a web site. Competition of the New Zealand online fashion industry will be more intense.

V. Conclusion

The New Zealand online fashion market is likely to become much more competitive as it becomes easier for traditional fashion merchants to conduct e-commerce. In general, a successful fashion web site should have rich and high quality content, fast loading speed, ease of navigation and good graphics. It is important for fashion web sites to frequently update their web site, offer new promotions, consider consumer preferences and improve their offerings over time. Fashion web sites should provide a safe shopping environment to consumers and inform consumers of the advantages to use the Internet to shop for fashion products. The main challenges faced by fashion organisations were getting the income stream from the fashion web sites and making it profitable. Above all, the New Zealand online fashion industry will continue to grow.

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Research on Issues Related to Virtual Reality Representation in Online Shopping System –Experimental Study on Spatial Location Relations among Objects Based on Visual Attention Theory

Li Jiangyu *, Yu Haibo **

* School of Economic & Business Administration,
Beijing Normal University, China, 100875
Telephone: 86-010-62261810, Fax numbers: 86-010-58801867
e-Mail: li_jy@126.com

** The Institute of Psychology
Chinese Academic of Sciences, China, 100101

Abstract: This article has studied influences of three factors namely flashing (FF), consistency (CF) and distance (DF) to spatial location array of commodity objects in online shopping system. The findings show that reaction time (RT) of subjects in still representation is shorter than that in live representation; faster in the setting of being inconsistency between commodities and their text description than that of being consistency; in the condition of both Flashing (FSH) level and Consistency (CON) level, Un-flashing (UNFSH) level and Inconsistency (INCON) level, subjects RT in the setting of commodity object being farther from its description is shorter than that in being near. The research finds no discrepancies that three factors have any impact on subjects' accuracy rate. Further analysis finds that physical distance of commodities plays a major role in affecting spatial location array of objects, while conceptual distance ranks on the second place. Location-based visual attention has the biggest impact on spatial location relation of virtual reality setting, and object-based visual attention plays a second largest impact. The impact would be highly impressive when either physical distant or conceptual distance is conformed to experiences in real life, Singleton detection mode will play a role at the situation when coincidence of the said phenomenon and real life experience is less, which means distinct flashing (FSH) will lead to better effect at this particular situation, otherwise it is worse.

Keywords: E-commerce Management, Internet Marketing & Advertising, Attention theory, virtual reality, location relations, shopping system.

I. Introduction

Some research finds that virtual reality representations of commodity information in online shopping systems will encourage buyers to reach an positive assessment on commodity information, and further inspires their desire of buying behavior[1]. This finding and further studies on affecting factors of VR representation to human information behavior or buying behavior in e-commerce websites grab a lot of attention from scholars and researchers, and ongoing

studies are implemented, for example: user structure pattern of virtual experience in VR environment; the relation between structure pattern and users' direct or/and indirect experience[2]. Another finding related to the means of media representations shows that VR representations have more advantages in improving performance efficiency specially when buyers are familiar to shopping systems or face higher frequencies of buying activities than Text representation, therefore, object information represented in VR plays a significant role on the success of online shopping systems[3].

In terms of representation on specific blocks of the interface and their relations, conventional researches focus more on micro-cognition elements such as interface layout, the characteristics of font and color and their relations with viewing behavior [4], which also are the issues of web interface our attention should be paid to, not limited in this, a further intensive attention should be paid to the different features and models of these elements in web environment [5], while some results might not be well applied to object representation in VR, and existing researches on this issue are much more scarce so far.

VR representation, in a way, can be interpreted as a means of presenting spatial relation which is largely based on intuition. It can easily lead to misunderstanding due to its capacity of sending diverse information simultaneously, so more aid such as text description are employed to reduce misunderstanding and non-clarity while user interacting with spatial activities in VR, so user can differentiate specific objects from its background or other elements unrelated to establish information cognition and activities pattern in VR environment[6]. Some researchers, from another point of view, have studied shopping design in real life and its applicability at VR stores, the impact of VR shop individuality on user's behavior[7]. In VR shopping environment, the issues of information behavior and location relations among objects still need more attention. This paper mainly studies the impact of attention theory on objects and object relations in VR setting.

II. Visual Attention Theory

Attention, in terms of the cause, can be divided into two classes: passive attention and active attention, some researchers also name them as stimuli-driven attention or

target-driven attention [8], yet two classes of attention are not mutually exclusive, sometimes, the development or controlling of the attention is worked jointly by the two. Passive attention often involves two modes: singleton detection mode and feature search mode. Singleton detection mode refers to the distinct difference of the stimuli (stimuli refers to the means of commodity representation in online shopping system) from the background. Feature search mode refers to the consistency of stimuli features and task features. Therefore, visual attention can be led to specific locations because of all said features.

Attention selection to the stimuli consists mainly of two categories: location-based visual attention and object-based visual attention. Location-based attention believes that attention is influenced by spatial array-format of objects. The selection accuracy and speed of subjects to searching objects are better and faster when objects appear near than they appear far. Other research findings support that the selection of searching objects are influenced by not only spatial location, but also location relations among objects. That is what we called object-based attention. Both two categories of attention will be explicated further by demonstrating an example. To explain location-based visual attention, we present a figure (1) of rectangle. An object can appear at each corner of the rectangle randomly. Subjects are asked to report another object's identity which is associated with the object as soon as it appears. The speed and accuracy of subject selection is faster and better when two objects are spatially set closer than they are far[9]. To explain object-based visual attention, we present a figure (2) of two same sized rectangles, the appearance of an object (named A here) appears with eighty percentage at fixation, and Bs either on left or on right side of A appear with ten percentage at any possible places, but the distance to A from either B remain the same. Subjects are asked to report as soon as either B appears, and subjects RT when B and A are in the same rectangle is shorter than that when B and A are in two separate rectangles[10,11]. It also reveals that simple detection task is more applicable to structure locations of objects, while objects identity task will require lots of attention paid to objects representations[12].

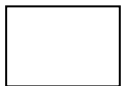


Figure 1

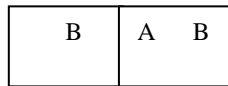


Figure 2

The research on visual searching finds that the speed of attention relocated to other objects and duration the attention kept on the objects have strong correlation with the relations among objects. The bigger discrepancies among objects exist, the longer the attention would be paid[13].

In VR representation of online shopping systems, users need experience different shopping sites and differentiate specific shopping objects while touring information space.

User attention will be constantly in the mode of stimuli or targets or the rotation of the two resulted from the changes of sites and man's cognition. Users will go through two subsequent stages: detection task and objects identity task. Detection task involves more direct experiences and attention to the location and space of the setting, while objects identity task involves more attention to specific object, its shape, its characteristic etc. To some extent, specific objects in VR shops should be distinguished from the background or other objects related since they have direct impact on buying decision and information activities. The demonstration of VR space can be the specific location relations of objects, the specific features of objects, or the combination of the two. The representation by either way will become clear in user mind when they catch more user attention successfully. In most case, the information related to objects should be placed in one sphere instead of two separate ones.

III. Hypothesis

Based on visual attention theory explicated previously, this article mainly focuses on spatial location relations among objects in VR setting, studies on effects of three factors to spatial location relations among objects have been made in VR online shopping system and three hypothesis are going to be validated. Namely, whether the result of task performed will be better? if 1. two objects sharing same characteristics are placed at a consistent location array. 2 two objects linking each other logically are near or placed in the same spatial range. 3 targeting object is distinct from its objects' background. In this article, objects and their description can be interpreted as two objects sharing same characteristics. Distance being either far or near can be interpreted as two objects being close or far. Objects are flashing will be interpreted as they are distinct from their background or vice versa.

IV. Method

Subjects : 80 sophomores from Beijing Forestry University (52 males, 28 females) are with little experiences of using computer, their average age is 20.13.

IV.1 Experimental Materials:

Eight VR settings has been employed, and each setting consists of three parts of shelf shaped like “ \wedge ”, each shelf has four booths divided by lines and placed at four corners of each shelf. Each commodity at booth accompanies a description indicating the nature of goods. Eight settings are different because of the array of three factors.

Flashing (FSH) refers to the change of commodity objects becoming either larger or smaller. Un-flashing (UNFSH) refers to the size of commodity objects remaining the same. Consistency (CON) refers that location relations of commodity objects and its description remain the same at

booth, namely it means commodity object always appears at lower left corner of the booth, while its description appears at upper right corner of the booth. Inconsistency (INCON) refers that location relations of commodity object and its description appear randomly at different places at booth. The definition of farther (FNR) or nearer (NR) depends on whether commodity object and its description are blocked off by a line while physical distance remains the same. If it is a line between commodity object and its description, it means FNR; if not, it means NR. Subjects can only view one booth containing four commodities while their entering into shopping settings. Subjects must “go around” if they want to view more booths or commodities. “Go around” and final selection of commodity objects here must be facilitated by moving mouse.

IV. 2 Experimental Task

A target object appears randomly out of 48 objects in the shopping center. Subjects navigate through the specific setting by means of the mouse. Subjects then click the “SELECT” button upon arrival at the target object, indicating completion of one task. The setting will disappear after task completion, and next target object will appear, which indicates the start of second task to be executed. Apart from objects, all commodities and their description in the setting appeared randomly.

IV. 3 Experimental Design

Three-factor within-subjects design (2x2x2) generated eight treatments which correspond with eight virtual reality settings. Eighty subjects were randomly grouped into eight teams evenly and assigned a treatment.

Independent Variables: Three factors and two levels in each factor, namely flashing factor (FF)-(flash vs un-flash), consistency factor (CF)-(con-incon) and distance factor (DF)-(farther vs nearer)

Dependent Variables:

1. Reaction Time (RT): The time a subject spends completing a task. Time begins when an object appears, and ends when the subject locates the object and clicks “SELECT.”
2. Accuracy: The percentage of all correct object-searching tasks performed by each subject. It is resulted from the ratio between the number of correct tasks done by subjects and the number of whole tasks to be done.

Controlled Variables:

Time Delay (TD): refers to about nine seconds lapsed while each scene appears on the screen of the computer.

IV. 4 Experimental Procedures

In each treatment (eight settings) subjects were first asked to read task instructions, and then perform a practice task in an attempt to let subjects be familiar to and understand the whole task to be implemented (practice task content was

unrelated to experimental task content). Subjects practiced ten search tasks before proceeding to the experimental tasks. As soon as a random target object appeared, subjects clicked “START”, then subjects navigated through shopping setting until the correct object was located, completing the search activity by clicking “SELECT.” A new random target object then appeared, initiating the second task. The search process was repeated twenty times by each subject, with the computer monitoring the whole process and recording all activities.

V. Experimental Results

V. 1 Reaction time (RT) under different treatments

Table 1: Reaction time under different treatments

FF	CF	DF	Mean(ms)	Deviance	Subjects
FSH	CON	FNR	13811	4728	8
		NR	13910	3135	9
		Total	13864	3834	17
	INCON	FNR	11975	1385	10
		NR	10976	2356	11
		Total	11452	1975	21
	Total	FNR	12791	3332	18
		NR	12296	3050	20
		Total	12531	3153	38
	CON	FNR	16103	6936	11
		NR	10848	3535	11
		Total	13476	6008	22
UNFSH	INCON	FNR	8922	1618	10
		NR	9551	2373	11
		Total	9255	2024	21
	Total	FNR	12684	6224	21
		NR	10200	3012	22
		Total	11413	4956	43
	CON	FNR	15138	6064	19
		NR	12226	3628	20
		Total	13645	5116	39
	INCON	FNR	10449	2145	20
		NR	10263	2420	22
		Total	10352	2267	42
Total	Total	FNR	12733	5036	39
		NR	11197.9860	3175.2211	42
		Total	11937.2331	4219.9678	81

Flashing factor=FF

Consistency factor=CF

Distance factor=DF

In general, RT used by subjects in FSH ($X=12530.7288$ ms) is less than that in UNFSH ($X=11412.7485$ ms) ; RT in CON ($X=13644.7608$ ms) is less than that in INCON ($X=10351.6716$ ms) ; RT in FNR ($X=12733.3453$ ms) is less than that in NR ($X=11197.9860$ ms) . These RT scores are then log-transformed to normalize the data ($RT \rightarrow \log(RT+1)$), then conduct ANOVA analysis (GLM General Factorial, SPSS for Windows 8.0).

The results appear graphically in Figure 3 and Figure 4. overall differences among eight treatments are highly significant ($F(7,73)=3.895, p<0.01$) . The main effect for FF ($F(1,79)=5.478, p<0.05$) and for CF ($F(1,79)=12.827$,

$p < 0.01$) both are significant. The three-way interaction among three factors is significant ($F(1,79)=4.162$, $p < 0.05$), however, there is no main effect for DF ($F(1,79)=1.726$, $p=0.193$). There is also no significant two-way interaction between FF and CF ($F(1,79)=1.085$, $p=0.301$), between FF and DF ($F(1,79)=0.643$, $p=0.425$) or between CF and DF ($F(1,79)=0.951$, $p=0.333$).

Figure 3 and Figure 4 shows that subjects RT in CON level is longer than that in INCON level at each level of both DF and CF. In other conditions except FNR level and CON level under flashing factor, subjects RT in FSH level is longer than that in UNFSH level. In CON level, subjects RT in NR and UNFSH condition is shorter than that in other conditions. In INCON level, the speed in FNR and UNFSH condition is faster than that in NR and UNFSH while the speed in NR and FSH condition is faster than that in FNR and FSH.

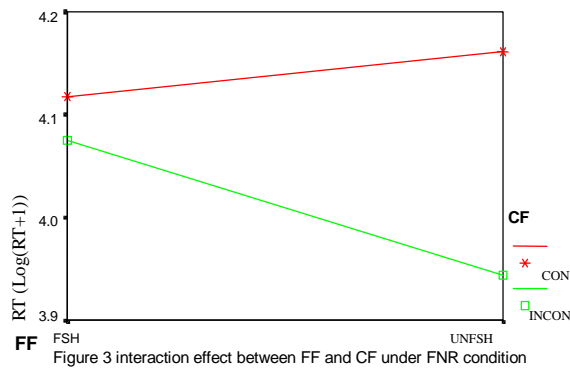


Figure 3 interaction effect between FF and CF under FNR condition

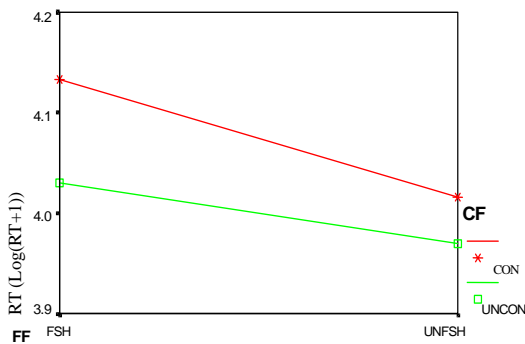


Figure 4 interaction effect between FF and CF under NR condition

V. 2 The accuracy under different treatments

Statistics analysis (GLM General Factorial in SPSS for Windows 8.0) shows that overall differences among treatments are not significant ($F(7,73)=1.466$, $p=0.931$). The main effect for FF ($F(1,79)=3.029$, $p=0.086$), for CF

($F(1,79)=1.194$, $p=0.278$) and for DF ($F(1,79)=2.644$, $p=0.108$) all are not significant. There is also no significant two-way interaction between FF and CF ($F(1,79)=0.042$, $p=0.837$), between FF and DF ($F(1,79)=2.699$, $p=0.105$) or between CF and DF ($F(1,79)=2.699$, $p=0.105$). The three-way interaction among three factors is also not significant ($F(1,79)=0.196$, $p=0.660$).

VI. Analysis and Discussion

In all, researching findings and hypnosis can't reach an agreement, and the impact of DF still remains unclear. The interaction of three-way factors will come to different results under different conditions.

The definition on CON level of consistency factor is that commodity object and its description are placed at diagonal corner in rectangle, actually, which makes the two being farthest physically. The definition of distance factor mainly refers to the conceptual distance between commodity objects and its description, and physical distance of two levels (FNR and NR) in distance factor is the same. It will be easier to understand that consistency factor involves physical location relation of the attention, while distance factor involves conceptual distance of the attention, and conceptual distance is a more objects-oriented process paid by attention, which is conformity with the said analysis. INCON level makes commodity object and its description nearest physically, which is coincidentally agreement with the setting at real life stores where tags are placed closely to commodities, therefore the similarity in location relations plays the greatest impact on subjects cognition, and help subjects identify objects at shortest time. CON level tells another opposite story at any conditions, that is results in Con level at any conditions are worse than that in INCON level.

Based on attention theory, the speed of human apperceiving live objects is faster than that of still objects if moving objects appear distinctly from the background. In CON and FNR condition, response speed of subjects encountering flashing objects is faster than that of unflashing objects, while in other conditions, opposite results are found, which is probably because subject mentality is required to identify objects description clearly first and give a judge whether they choose right targets, while flashing objects more easily grab subject's instinct attention. The process of this specific task would follow the pattern: subjects' attention moving to flashing objects first—then to objects description to identify the correction—then to search target object after judgment, the whole process slows down the cognition speed. If objects are not flashing, the attention of subjects will be paid directly to objects, which accelerates cognition speed. Therefore results of farther level in FSH and CON condition is better than that of nearer level because being farther further reduced the impact of distance. Apart from this, in other conditions, other factors affecting cognition is greater than flashing. In CON and FNR level, it can be interpreted as the worst cognition mode since both

physical and conceptual distance are fair faraway. Cognition results are better in other conditions because physical distance and conceptual distance are near. In other conditions, subjects RT in flashing level is shorter than that in un-flashing.

Based on the studies and experiments, the conclusion drawn is that physical-distance influence on location relations among objects is biggest, conceptual distance is on second place. In terms of attention theory, the influence on location relations by location-based attention is bigger than that by object-based attention. Performance results are better when the said phenomenon is coherent with experiences in real life. Singleton detection mode will play a role at the situation when coincidence of the said phenomenon and real life experience is less, which means distinct flashing will lead to better effect at this particular situation, otherwise it is worse. It helps us better understand and establish VR shopping settings, to use more location relations in physical terms to represent the relations of objects instead of conceptual terms; to place commodity objects which are similar to each other at more close locations as so to reveal more information about commodities, however location relations of three factors determining buying decision need be further studied.

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A Review of Copyright Protection Approaches in Electronic Commerce (Watermarking Method)

Seyed Kamal Vaezi, Ph.D.

Institute of Information Technology, Tarbiat Modares University.
Iran's Ministry of Sciences, Researches and Technology
vaezi_ka@yahoo.com

Abstract: Digital watermarking is the best way to protect intellectual property from illicit copying. Digital watermarks hide the identity of an image or audio file in its noise signal. A pattern of bits inserted into a digital image, audio or video file that identifies the files copyright information. The purpose of this paper is to provide copyright protection for intellectual property that's in digital format. In this career we review digital watermarks an application of steganography.

Keywords: Internet, Security & Privacy, Intellectual Property, Copyright, Electronic commerce, Watermarking

I. Introduction

Before the advent of the Web, people made audiotape copies of music and videos to give to friends and family or used them for their own personal enjoyment activities were ignored by the producers, distributors, and artists who had the legal rights to the content MP3.com, Napster, and Intellectual Property Rights MP3.com enabled users to listen to music from any computer with an Internet connection without paying royalties Using peer-to-peer (P2P) technology, Napster supported the distribution of music and other digitized content among millions of users MP3.com, Napster, an Intellectual Property Rights MP3 and Napster claimed to be supporting what had been done for years and were not charging for their services Popularity of MP3.com and P2P services was too great for the content creators and owners to ignore MP3.com, Napster, and Intellectual Property Rights.)

To the creators and owners, the Web was becoming a vast copying machine MP3.com's and Napster's services could result in the destruction of many thousands of jobs and millions of dollars in revenue MP3.com, Napster, and Intellectual Property Rights .

December 2000, E-Music (emusic.com) filed a copyright infringement lawsuit against MP3.com

In 2001, Napster faced similar legal claims, lost the legal battle, and was forced to pay royalties for each piece of music it supported—Napster collapsed—in October 2003 it reopened as “for fee only” MP3.com, Napster, and Intellectual Property Rights . Existing copyright laws were written for physical, not digital content. The Copyright Infringement Act states, “the defendant must have willfully infringed the copyright and gained financially”.

The “no financial gain” loophole in the Act was later closed MP3.com, Napster, an Intellectual Property Rights (cont.)

The Results In 1997, the No Electronic Theft Act (NET) was passed, making it a crime for anyone to reproduce and distribute copyrighted works applied to reproduction or distribution accomplished by electronic means even if copyrighted products are distributed without charge, financial harm is experienced by the authors or creators of a copyrighted work MP3.com, Napster, and Intellectual Property Rights (cont.)MP3.com suspended operations in April 2000 and settled the lawsuit Napster suspended service and settled its lawsuits tried to resurrect itself as an online music subscription service with the backing of Bertelsmann AG filed. for bankruptcy in June 2002 purchased by Roxio with plans to revive Napster into a royalty-paying framework MP3.com, Napster, and Intellectual Property Rights .

What we can learn :All commerce involves a number of legal, ethical, and regulatory issues EC adds to the scope and scale of these issue What constitutes illegal behavior versus unethical, intrusive, or undesirable behavior?

Ethics is The branch of philosophy that deals with what is considered to be right and wrong ,What is unethical is not necessarily illegal.

Ethics are supported by common agreement in a society as to what is right and wrong, but they are not subject to legal sanctions Legal Issues Versus Ethical Issues .

Employees use e-mail and the Web for non-work-related purposes.

The time employees waste while surfing non-work-related Web sites during working hours is a concern Copyrighted trademarked material cannot be used without permission

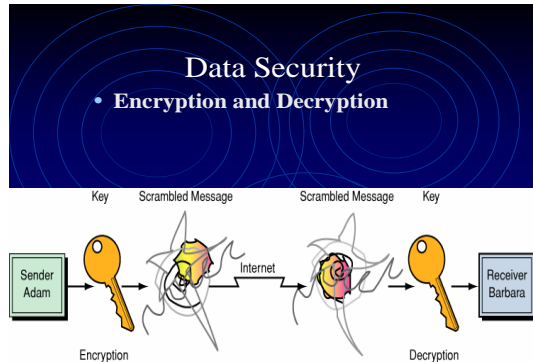
Post disclaimers of responsibility concerning content of online forums and chat sessions

Legal Issues Versus

There are ten topics used for Checking IP issues in e-commerce(by WIPO)

- 1- Understanding how IP relates to e-commerce
- 2- Taking Stock of your IP assets relevant to e-commerce
- 3- IP issues when you design and build your website
- 4-IP issues related to internet domain names.
- 5-How your e-commerce is affected by patents

- 6-IP issues in the distribution of content on the internet
- 7- Using care in disclosures on the internet
- 8- Important contracts on the internet
- 9- partnerships with government and educational system
- 10 – IP concerns about international transactions in e-commerce



Copyright is an exclusive grant from the government that allows the owner to reproduce a work, in whole or in part, and to distribute, perform, or display it to the public in any form or manner, including the Internet

Copyrights.

Copyright protection approaches Using software to produce digital content that cannot be copied Cryptography

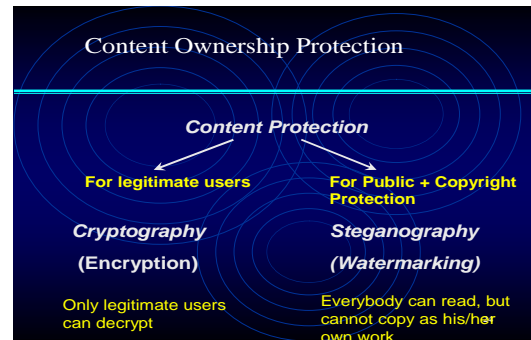
Tracking copyright violations

Digital watermarks is Unique identifiers imbedded in digital content that make it possible to identify pirated works. Cryptography is the art of protecting information by transforming it ([encrypting](#) it) into an unreadable format, called [cipher text](#). Only those who possess a secret key can decipher (or [decrypt](#)) the message into [plain text](#). Encrypted messages can sometimes be broken by cryptanalysis, also called code breaking, although modern cryptography techniques are virtually unbreakable

Cryptography.

As the [Internet](#) and other forms of electronic communication become more prevalent, electronic [security](#) is becoming increasingly important. Cryptography is used to protect [e-mail](#) messages, credit card information, and corporate data. One of the most popular cryptography systems used on the Internet is [Pretty Good Privacy](#) because it's effective and free.

Cryptography systems can be broadly classified into [symmetric-key systems](#) that use a single key that both the sender and recipient have, and [public-key](#) systems that use two keys, a public key known to everyone and a private key that only the recipient of messages uses.



Range of Knowledge Management

II. Digital Watermarking

Digital watermarking is the best way to protect intellectual property from illicit copying.

Digital watermarks hide the identity of an image or audio file in its noise signal.

Controlling spam

Spamming is the practice of indiscriminately broadcasting messages over the Internet (e.g., .. junk mail)

Spam comprises 25 to 50% of all e-mail

Free Speech Versus Censorship and Other Legal Issues .

Electronic Mailbox Protection Act requires those sending spam to indicate the name of the sender prominently and include valid routing information

Recipients may waive the right to receive such information

Free Speech Versus Censorship and Other Legal Issues .

ISPs are required to offer spam-blocking software

Recipients have the right to request termination of future spam from the same sender and to bring civil action if necessary

Free Speech Versus Censorship and Other Legal Issues

Electronic contracts

Uniform Electronic Transactions Act of 1999 establishes uniform and consistent definitions for electronic records, digital signatures, and other electronic communications

–Shrink-wrap agreements or box-top licenses

–Click-wrap contracts

Free Speech Versus Censorship and Other Legal Issues (cont.)

Intelligent agents and contracts

Contracts can be formed even when no human involvement is present

A contract can be made by interaction between an

individual and an electronic agent, or even between two electronic agents

Free Speech Versus Censorship and Other Legal Issues (cont.)

Uniform Electronic Transactions Act (UETA) includes the following two provisions:

- Electronic records do satisfy the requirement for a contract
- Electronic signature is enforceable equal to a written signature on a paper contract

Free Speech Versus Censorship and Other Legal Issues .

Internet Gambling Prohibition Act of 1999 Online wagering illegal except for minimal amounts Provides criminal and civil remedies against individuals making online bets or wagers and those in the business of offering online betting or wagering venues Free Speech Versus Censorship and Other Legal Issues .

Taxing business on the Internet

Internet Tax Freedom Act passed the U.S. Senate on October 8, 1998 Barred any new state or local sales taxes on Internet transactions until October 2001 (extended by US Congress to 2006) Created a special commission to study Internet taxation issues and recommend new policies Free Speech Versus Censorship and Other Legal Issues .

The global nature of business today suggests that Cyberspace be considered :A distinct tax zone unto itself

Unique rules and considerations befitting the stature of the online environment Free Speech Versus Censorship and Other Legal Issues .

Tax-free policies may give online businesses an unfair advantage—Internet businesses should pay their fair share of the tax bill for the nation's social and physical infrastructure.

8- Important contracts on the internet

9-partnerships with government and educational system

10 – IP concerns about international transactions in e-commerce

•Cryptography

•Tracking copyright violations

•Digital watermarks: Unique identifiers imbedded in digital content that make it possible to identify pirated works

Content Ownership Protection

Cryptography

•The art of protecting information by transforming it ([encrypting](#) it) into an unreadable format, called [cipher text](#). Only those who possess a secret key can decipher (or [decrypt](#)) the message into [plain text](#). Encrypted messages can sometimes be broken by cryptanalysis, also called

codebreaking, although modern cryptography techniques are virtually unbreakable

Data Security

Data Security

Cryptography(cont.)



As the [Internet](#) and other forms of electronic communication become more prevalent, electronic [security](#) is becoming increasingly important. Cryptography is used to protect [e-mail](#) messages, credit card information, and corporate data. One of the most popular cryptography systems used on the Internet is [Pretty Good Privacy](#) because it's effective and free.

Cryptograohy

Cryptography systems can be broadly classified into [symmetric-key systems](#) that use a single key that both the sender and recipient have, and [public-key](#) systems that use two keys, a public key known to everyone and a private key that only the recipient of messages uses.

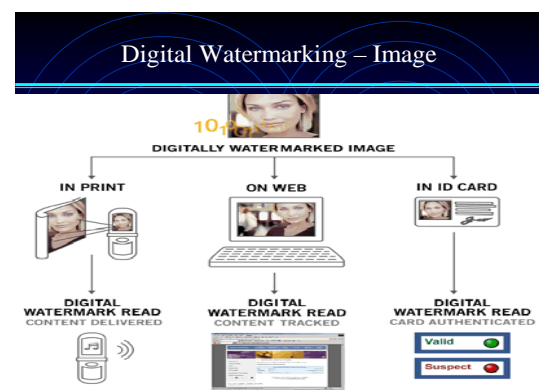
“Digital Watermark”

Watermarking: An application of Steganography.

Digital Watermarking

•Digital watermarking is the best way to protect intellectual property from illicit copying.

•Digital watermarks hide the identity of an image or audio file in its noise signal.



Digital Watermarking – What is it?

Digital Watermarking is a form of steganography which embeds usually imperceptible or invisible markings or labels in digital data in the form of bits.

Digital Watermark

Interest in digital watermarks has grown out of an increasing interest in intellectual property and copyright protection.

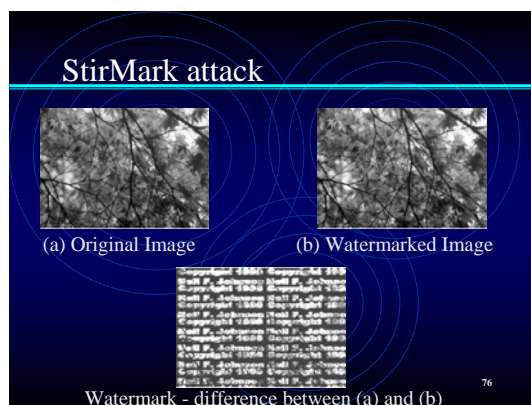
Digital Watermark .

Digital watermarks provide means of placing additional information within digital media so if copies are made, the rightful ownership may be determined.

III. Digital Watermark

Digital watermark ,a security software, are added to still images in a way that can be seen by a computer but is imperceptible to the human eye. A Digital watermark carries a message containing information about the creator or distributor of the image, or even about the image itself.

Digital Watermark (cont.)



Embeds imperceptible messages for tracking down the sites to check for abuses

- Encrypts data that only prospects users can read by using “Digital Key”
- Places icon or logo of copyrights’ owner in the corner of the screen or page

Embedded information

The embedded information is known as a watermark can provide, for example, information about the media, the author, copyright, or license information.

Digital Watermarking

- Embed visible / invisible watermark data into objects without changing the original document format and contents.

$$C = E(wm, P)$$

- Embedding watermark wm into object P , producing watermarked object C .

- Watermark can contain object ID, author’s name, terms of use, copyright date and so forth.

- Watermark can be either visible or invisible.

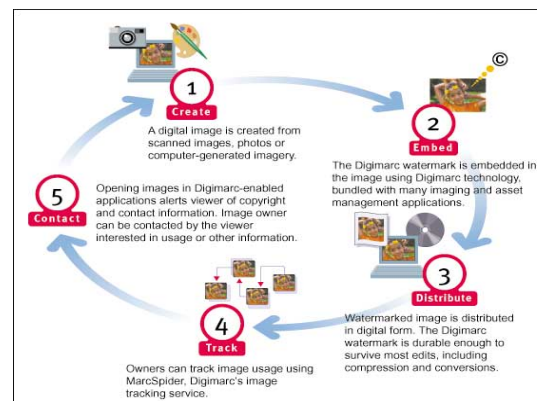
- Watermark recovery

$$D(C) = wm$$

- Applying watermark extraction to recover watermark, proving ownership.

- Good evidence in a copyright court.

- For a good watermark scheme it should be difficult to removed the watermark without knowing the embedding algorithm (and key).



Digital Watermarking - Examples

- Text – varying spaces after punctuation, spaces in between lines of text, spaces at the end of sentences, etc.
- Audio – low bit coding, random imperceptible noise, fragile & robust, etc.

- Images – least-significant bit, random noise, masking and filtering, etc.

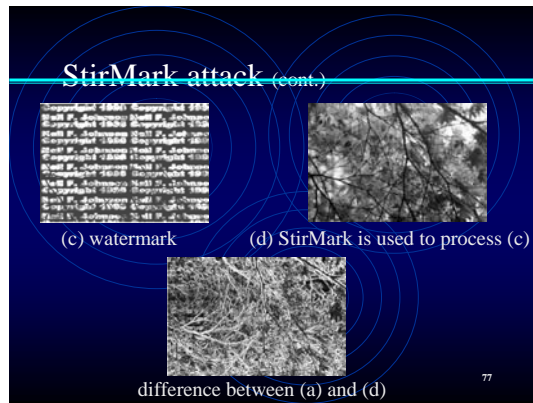
Digital Watermarking Example

Digital Watermarking – Purposes

Digital Watermarking – Qualities/Types

Digital Watermarking – Case Studies

- Text



- Image

- Audio

- Video

Digital Watermarking – Image

Digital Watermarking - Images

- Digimarc Image Bridge

- Inserts imperceptible digital watermarks onto images

- Digimarc MarcSpider

- Tracks all images with Digimarc's watermark on the Internet

- Searches over 50 million images on the Internet a month

MarcSpider report

Who is using ImageBridge and MarcSpider?

- Corbis

- Workbookstock.com

- The British Library

Success Story

- Cobris

- identifies up to 50 cases of unauthorized commercial use of its images per month

- Settled 28 cases in and out of court in 8 months

- Movie Market paid 1 million for the settlement

Digital Rights to Entertainment Media

- Internet makes it easy to transfer video content

~350k movies/day illegally downloaded via Internet.

Broadband access enables transfer of full length movies in < 40 minutes

Next generation technology may reduce the time 45 seconds
500k to 1mm simultaneous users find, reproduce and redistribute entertainment content via file sharing services

- Sales of audio and video packaged media dropping rapidly

Record and CD sales down 10% last year

Top ten album sales dropped from 60mm in 2000 to 40mm in 2001

Digital Watermarking - Video



Watermark is insert into video by production studio, broadcast station, or cinemas

- Watermark contains copyright information and copying restriction information that indicates the video can be copy once, copy unlimited times, or never copy

- Video recording equipments manufactures have to agree with the code, and make the equipments accordingly

Digital Watermarking - Video

- Universal Pictures

- Insert digital watermarks in its movies including theatrical release, home video, video on demand, and broadcast movies

- Work with video recording makers in the next few years to ensure that new devices will complied the new standards

Video Watermarking Applications

Watermarking for Copy Protection

Copyright Protection Ecosystem

Philips Digital Network Water Cast

Who is using Water Cast?

- BBC

- Reuters

- EBU

Digital Watermarking - Audio

- Cannot effectively prevented illegal use of music on the Internet

- Identify the source of the music, and determine if the music is legal or not

- In 1999, a few companies including Liquid Audio, MP3, CDnow, formed a coalition to have digital watermark on distributed music on the Internet

Digital Watermark – National Security

- Insert watermark into ID card

- Carry secure information, which is used to authenticate and verify cardholder

- Harder for counterfeiter to replicate the ID card

Image Watermarking

Digital Watermark

Digital Watermark

Digital Watermark

Benefit from Implementing Digital Watermark Technology

- Communicate owner, image and/or transaction specific information, providing additional detail valuable for directing potential customers directly to appropriate licensing information.

Benefit from Implementing Digital Watermark Technology

- Facilitate image specific licensing and commerce opportunities by enabling each image to direct customers to image specific information on your Web site.

Digital Watermarking – Attacks

Attackers can seek to destroy watermark for the purposes of use without having to pay royalties to the originator of the content.

Types of Attacks

- Attackers have a visible target and can remove the watermark by cropping the image.

- Attacks on watermark may not necessarily remove the watermark, but disable its readability.

- Multiple watermarks can be placed in an image and one cannot determine which one is valid.

Types of Attacks (cont.)

- Robustness attacks – seek to degrade watermark beyond its utility value without altering the quality of the content so that the watermark cannot be detected

- Presentation – seek to manipulate content so that a detector cannot find the watermark in the file (i.e slicing an image into pieces and then reassembling it on a web site)

- Interpretation – create duplicate watermarks in order to create an ownership conflict

- Legal – challenging legal aspects of watermarking

StirMark attack

StirMark attack (cont.)

Question?

VWM: Protecting Movies from Piracy

- VWM Group formed March 2001

Macrovision, Philips, Sony, NEC,

Hitachi, Pioneer, Digimarc

- Copy prevention and play control

- Tens of Millions of dollars invested in watermarking technology

- Global standards initiatives

US: DVD CCA bids submitted 11/01; decision before mid-year

Europe: DVB-CP (coordinated through EBU)

Japan: ARIB (broadcast standards organization in Japan)

- Market need becoming critical

Production of DVD recordable devices ramping

US debating mandatory copyright protection in all digital devices

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Information Security Guidelines for Healthcare Institutions

Chao-Ming Chen

Institute of Healthcare Information Management
National Chung Cheng University, Taiwan
168, University Rd, Min-Hsiung Chia-Yi, Taiwan, R.O.C.
TEL: 886-5-2721500 FAX: 886-5-2721501
u8824341@yahoo.com.tw

Abstract: In recent years, the form of medical records already slowly changed from paper form to electronic form. The new information science and technology makes the transmission of information easier and convenient. On the other hand, the exposedness of individual privacy and information secret would be too difficult to keep and the use of new science and technology has increased the risk of information leakiness.

The information security problem appears slowly in the electronic medical record. People that are indiscreet and negligent could cause improper damage to the information management. For this reason, the security guidelines could help healthcare institutions to improve insider and outsider security problem. The security guidelines should refer to BS7799 and HIPAA that we would take many advantages. Finally, we must estimate the benefit from purchase, integration, management, operations, maintenance, time lost, clumsy interfaces and procedures etc. These may spend a lot memory and time, so we should evaluate the cost and risk of BS7799 and HIPAA in each item; it could help us to guide how to select low cost, low risk and high benefits standard item to create the security guidelines.

Keywords: Internet Security and Privacy.

Introduction

The Information System in 21 th already to become the hospital essential tool, specially may increase efficiency of information system and reduce the cost.. However, the computerization of health information, while offering new opportunities to improve and streamline the healthcare delivery system, also presents new challenges to security problems and individual privacy interests in personal healthcare data [4].And The medical record exchange and the share has hastened for the current situation, grows the security problem which comes, creates patient's privacy and individual data enormous threat .Patient's data has the high sensitivity, most did not hope has a mind the public figure to the data exchange when is carried on revises correct or steals, perhaps in exchange process because controls the tube not when creates the internal outside the data to release. .In health care, because of these security risks and the uncertainty of security requirements in electronic networks, providers often discourage the use of electronic networks for the transmission of most patient data and other sensitive

information [1], [7].

Recognizing the potential dangers to computerized patient information, Congress mandated the implementation of system security standards through the Health Insurance Portability and Accountability Act [(HIPAA) Public Law 104–191], requiring the adoption of security standards that take into account the technical capabilities of record systems used to maintain health information [4].So we ready need a guidelines that told Hospital's high level manager how to control risk、 risk management、 security plan....because all most managements have not any idea to security for Hospitals, if Manager have a security guideline , could help them to make security plan、 control Risk and Risk management. But the security standards like BS7799 or HIPAA have too many control objectives that hospitals could not implement all control objectives. Because of the most hospitals resources is limited.

Threats of Health Care Information

According to Daniel P. Lorence and Richard Churchill 's research that paper-base of Healthcare Institutions could provide more security more than computer-base of Healthcare Institutions.

This is because Healthcare Institutions even have a lot of security problem in paper base work. And what's security problem are in our Healthcare Institutions. The consensus among health care CIOs is that the most important threats to patient information confidentiality are the following Table 1[9]:

Table1

Threats
1.From inside the patient care institution <i>Accidental disclosures.</i> <i>Insider curiosity.</i> <i>Insider subornation.</i>
2.From within secondary user settings
3.Outsider intrusion into medical information systems

Table 1 show we the threats all most come from Insider of Healthcare Institutions So Healthcare Institutions must

have the better internal control mechanism.

BS7799 and HIPAA

The BS 7799 Code of Practice is intended for use as a reference document by managers and other persons responsible for the information security within an organization. It is intended as a standard for the management of information security rather than for the practice of information security itself. In other words, it does not set out to be a technical manual but rather describes the sorts of controls that should be in place and how they should be managed. It may be regarded as a basis upon which to build a security policy but is not meant to be a definitive list of the measures that should be in place in every organization.[8]. Common is suitable each industrial BS7799, because the Healthcare Institutions has its industrial characteristic, specially in organization surface, therefore should join following several projects to take the thanking improvement the goal.[10] :

1. Medical records protections stipulation, maintains the patient's privacy not to violate.
2. The patient's information security rights, stated and protection patients the right which goes see a doctor in the hospital.
3. Outside of hospitals the use patients data, outside the hospital organization or the unit request obtains patients data, should request to observe stipulation the hospital correlation.
4. Medical records storage, guarantees patients medical record storage the security.

The right of privacy speaking of sickness is extremely important, specially in the nowadays democracy social privacy is current the important subject which takes, studies according to Cai Chia Ting [2] pointed out 95% managers of Healthcare Institutions all thought the medical information security and the privacy are the present hospital management important topic. Especially in data exchange or share time we must need to consider the secure question. But based on the Healthcare Institutions characteristic should hold the privacy to patient information, the security, and the secret and so on the characteristic, this also is several important ideas which in HIPAA emphasized, especially on Healthcare Institutions.

What Kind of Assets Need to Protect.

The common information system security Threats has following several kind of like Table 2. all Healthcare Institutions must be select some important controls to protect because they resources is limit. Many organizations have developed information systems for the collection and storage of patient data, but do not adopt corresponding security committees or teams, nor security manager/officers or coordinators According to Daniel P. Lorence and Richard Churchill[3]

Table 2 [6]

Natural and political disasters	Fire or excessive heat, Floods, Earthquakes, High winds, War and terrorist attack.
Software errors and equipment malfunction	Hardware or software failures. Software errors or bugs Operating system crashes. Power outages and fluctuations. Undetected data transmission errors.
Unintentional acts	Accidents caused by: Human carelessness Failure to follow established procedures Poorly trained or supervised personnel Innocent errors or omissions. Lost, destroyed, or misplaced data. Logic errors.
Intentional acts (fraud & computer crime)	Sabotage Computer fraud Misrepresentation, false use, or unauthorized disclosure of data. Misappropriation of assets. Financial statement fraud.

How Analyzes the Information Security Weakness.

The BS 7799-2 specifies requirements for establishing, implementing and documenting information security management systems (ISMSs). It specifies requirements for security controls to be implemented according to the needs of individual organization.

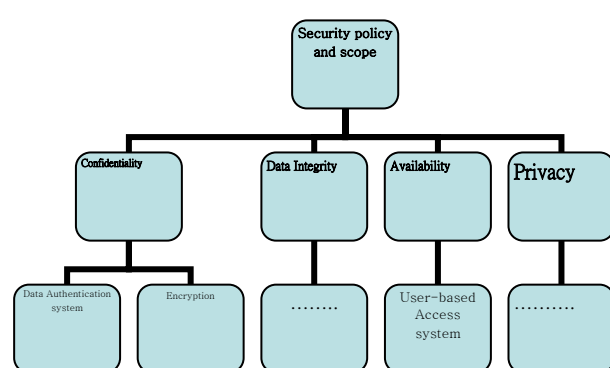
How to Establishing a Management Framework

The information safety control because HIPAA has considers the right of privacy protection the part, therefore uses HIPAA to discover the healing institute the item which must pay attention regarding the information security, finally coordinates the item which the electronic medical record clearing house must pay attention, and weakness which possibly can have on the present domestic electron medical record safe exchange overhead construction proposes the suggestion method. Must be able to complete the information to be safe first must finish the information security the management, first should appraise each control goal with can accept the risk which the risk and possibly can have, second is the selectivity control goal and reduces the risk to the scope which can accept, third avoids the risk and the shift risk arrives the third party, suggests the method, fourth carries on the safe plan which explained on front the development and the thorough execution and the revision, this for the information security and flow of and the executive program the internal control necessity, its specify and the method as follows explained: [5]

1. Define the information security policy and the scope of the information security management system:

First must look according to, security, the secret, uniformity major term and so on private dense launches lists our system scope and information security policy. Figure 1 shows an

example tree that the information security policy and the scope of the information security management system could be defined by the tree. We could List Confidentiality、Data Integrity、Availability and Privacy in the parent and we could list detail items in the subtree. That several information system needs to protect. appraised each control goal with can accept the risk which the risk and possibly can have: We want to decide on the protection policy which the medical record exchange security needs, and discovers the scope and the project which the electronic medical record exchange the system must protect, and appraised its risk with the resources which must consume, because resources limited, we are impossible to various information property all to make the consummation the protection, has the risk regarding each kind of possibility which the risk all must perform to calculate possibly occurs to have high.



2. Risk assessment and management:

selectivity controls goal and reduces the risk to the scope which can accept: This time must after various information property appraise grades makes the different rank in view of the different information property the protection, receives in view of the goal which must control carries on the security aspect the disposition and the tube controls, falls the risk the degree which can accept to us, exchanges by the electronic medical record said regarding the information bank protection, the material protection is count for much, may prepare under the enough resources situation as soon as to prepare in addition helps the main engine to carry on the backup the movement, can largely reduce the risk, and falls the risk which the information bank material drains to fall to the scope which may accept.

We should have clearly to know in the organization in this stage the material flow. The convention the organization of inside of the expert conference to obey HIPAA and the BS7799's control items confirm decides the important degree, and then List all of the control items in the checking table.(ex table 3). A score is determined for each alternative. The perfect alternative has a score of 1.0. The score for an alternative always lies between 0 and 1.0 and each score is determined independently of the scores of the other alternatives. Alternatives with identical scores are considered tied or equally close-to-perfect in the evaluation.

The weights to be used for the criteria, sub-criteria, and

the intensity levels at each level of the tree using pairwise comparisons are determined. Let $C(i,j)$ be a pairwise comparison that the decision-maker makes between two elements i and j , which are children of a node in the AHP tree (the children are also nodes in the AHP tree). Each pairwise comparison can be interpreted as a ratio scale. For elements i and j on the same level of the tree, $C(i,j)$ can be interpreted as follows: [5]

$$C_{ij} = \frac{\text{The weight the decision-maker would like to assign to element } i}{\text{The weight the decision-maker would like to assign to element } j.} \quad (1)$$

$$\text{weight} = \frac{1}{\sum \text{row}(i)} \quad (2).$$

Table3

	Outpatient System	Hospitalization System
Outpatient System	1	2
hospitalization System	1/2	1
weight	0.67	0.333

We could assign the information security of budget according to on table weight. Achieves most has the benefit the resource distribution and using the company information assignment, this uses above the information security, without the capital original assignment is insufficient.

3. avoids the risk and the shift risk to the third party:

We may the risk which may estimate avoid letting he occur, perhaps the risk by way of insurance giving to the insurance company which insures.

4. The Security plan development:

Finally we had to defer to a moment ago the risk height different project, started with organization resources how many to carry on the safe plan the plan and the development.

5. Implementation:

Carried on according to the information security plan content safely controls the tube, including organization's resources AND-OPERATION flow control, and the explicit definition power and responsibility, had the flaw regarding the process in which occurred to be supposed to record, then will be allowed to develop the security plan to take the improvement in the future the basis.

The conclusion

Security takes the degree on the present healing institute to the information not to be high, although knew has the information security but not to know how does, now this research specially chooses the electronic medical record material to exchange this subject, hoped can impel the electronic medical record exchange while the government

also to consider the information peaceful comprehensive thing, this research thought the information security and the electronic medical record material exchange is a body, is does not have the means to cut, therefore this research showed the information security control process, because the information security control is the information security basic condition, after achieves the information security control the request, the healing institute only then has the ability reference, This research establishment information security direction and composition. Healing institute's information is security also in the start stage, but also has quite many subjects not to have the means to make the detailed discussion in this research, why like does the healing institute affect the security the factor? The influence has in a big way? The risk has high? How deals with these security issues the countermeasure is what? ... And so on all is the quite interesting subject, might take the futurology subject the reference.

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E-Literacy in Pacific Asia

Nena Lim¹, Colin Ferguson²

¹limn@unimelb.edu.au ²colinf@unimelb.edu.au

Department of Accounting and Business Information Systems
The University of Melbourne, Melbourne, VIC 3010, Australia

Abstract: Hesitant about Internet security has been a major obstacle to consumers' acceptance of electronic commerce. The objective of this paper is to assess how consumers in Pacific Asia perceive Internet security and how much they know about the topic. A total of 182 university students from Australia and Hong Kong SAR participated in this study. The results show that respondents in these two Pacific Asia regions had similar level of e-literacy. Both groups were unsure about Internet security and their self-assessed knowledge of Internet security was relatively low. A closer analysis of the data suggests that respondents have a tendency to over-estimate their understanding of the Internet security.

Keywords: Internet security and privacy, e-literacy.

I. Introduction

The rapid growth and influence of the Internet is increasingly pervasive in our everyday life. Businesses make use of the Internet to facilitate marketing, training, as well as improve their relationships with their suppliers and customers. Despite an increasing number of consumers who adopt electronic commerce, the overall adoption rate of electronic commerce has so far been below expectation [1]. As a result, much research tries to investigate what motivates consumers to purchase products or services online [2] [28]. For example, [35] examine choice and convenience issues. Interestingly, although security was considered to be a building block for electronic commerce growth [29] and hesitant about Internet security has been found to be a major obstacle to consumers' acceptance of electronic commerce [17] [27] [30] [31] [38] [40], most Internet security research focuses on developing more advanced and sophisticated Internet security measures [25] [36] [37] and assume consumers are knowledgeable about the topic [10].

Little research to date has examined how much consumers know about or understand Internet security. The importance of educating company staff electronic commerce (e-commerce) knowledge was emphasized in [34]. Researchers have proposed to investigate individuals' knowledge of security threats and countermeasures [7]. In another study, 275 undergraduate students from three different states in the United States were asked how they perceived Internet security and whether they knew any of the security control techniques used by business [17]. The

results show that 80% of respondents believed that Internet vendors use security control measures to protect customers. In addition, nearly 70% of respondents had heard of encryption, about 50% had heard of secure electronic transaction (SET), but only one-fourth had heard of secure socket layer (SSL). Nonetheless, hearing about certain security techniques equals neither understanding nor trusting of those security techniques.

Many consumers worldwide are attracted to use the Internet especially the WWW because of its friendly graphical user interface. Nevertheless, the majority does not know what security measures are used by businesses, how the measures work to enhance Internet security, and what limitations the measures have. Even experienced computer users or Internet users are likely to have only limited knowledge on Internet security. The problem is, without a reasonable level of knowledge of Internet security such as digital certificates, it means that security can be easily compromised because of the ignorance of users [36]. If a consumer is confronted with a warning regarding suspicious server digital certificate while accessing a Web-site, it is unlikely he/she understands what it means or knows what to do [16]. The objective of this study is to assess how consumers in Pacific Asia perceive Internet security and how much they know about the topic.

The rest of this paper proceeds as follows. Section 2 briefly describes the different components of Internet security. Section 3 describes the research methodology. Section 4 describes the technology adoption situations in Australia and Hong Kong SAR. Section 5 presents the research results. Finally, the paper is concluded in section 6.

II. Internet Security

As the Internet is boundless, how can one party be sure the identity of the other party in an Internet transaction and ensure information can be exchanged in a secure manner? One of the strategies businesses use to tackle this problem is the adoption of digital certificates (also known as electronic certificates) for Internet communications and transactions [3] [33]. Each digital certificate includes information such as the name of the certificate holder/organization, a unique serial number, the expiration date of the certificate, a copy of the certificate holder/organization's public key, and a digital signature of the certification authority. The objective of digital certificate is to verify the identity of an individual or organization in the cyber world. It is similar to real world how individuals use passports to identify themselves. The importance of digital certificates should not be

underestimated. An incident in 2001 which involved Verisign issued two certificates mistakenly as Microsoft staff has caused Microsoft Corporation to issue a major update of its software [8] [19].

The mechanism of digital certificates relies on a public key infrastructure (PKI) to achieve on-line authentication [8]. Based on a model of trust [12], a PKI is a system for issuing, distributing and using public keys used in public key cryptography [24] [37]. It comprises digital certificates, certificate authorities and key repositories, etc. [12] [24]. The underlying mechanism of a PKI relies on public key cryptography which was developed in 1970s [21] [24]. Public key cryptography involves two mathematically related keys - private and public keys. Private and public key pairs are issued by trusted third parties called certification authorities (CA) [39]. Under a PKI, individuals with no prior relationship can achieve confidentiality and authentication when they swap information over the Internet or conduct electronic commerce transactions [21]. As a result of a PKI system, individuals and organizations can digitally sign and encrypt email messages. Moreover, two parties, typically a business Web sever and a consumer, can set up a secure socket layer session to exchange information safely [26].

III. Research Methodology

To examine the research questions, we conducted a Likert-scale style survey. We chose samples from Australia and Hong Kong SAR because these two regions were ranked the highest in Pacific Asia in Economist Intelligence Unit (EIU)'s annual report on e-readiness in 2003. In that report, Australia ranked the 9th and Hong Kong SAR ranked the 10th (tied with Canada) [18]. Two Scandinavian countries, Sweden and Denmark, were ranked number one and two on EIU's 2003 e-readiness ranking. E-readiness measures a region's capability to benefit from the opportunities provide by the Internet. Factors considered in the EIU rankings include the following: connectivity and technology infrastructure, business environment, consumer and business adoption, legal and policy environment, social and cultural infrastructure, and supporting e-services.

In January 2004, questionnaires were distributed to one hundred and fifty undergraduate students who major in accounting in Hong Kong SAR. One hundred and forty questionnaires were returned but one was unusable because of missing data. A similar survey was conducted in Australia in September 2004. Questionnaires were distributed to sixty-two postgraduate students. Forty-two were returned. Participation in the study was voluntary and no incentive was provided.

IV. Computer and Internet Usage

By March 2004, Australia has a population of 20 million [6]. Sixty-six percent of households in Australia have computers at home and among these five million households, 80% also have Internet access [5]. While 83% of Australian businesses

use computers, only 23 percent of businesses have Web presence [4].

Similar situation of computer and Internet access in households was found in Hong Kong SAR. By 2004, Hong Kong SAR has a population of 6.8 million [13]. Sixty-eight percent of households in Hong Kong SAR have computers at home and nearly all these household (89%) have Internet access [14]. Nevertheless, the penetration rate of computer and Internet in the business sector is much lower in Hong Kong SAR than Australian businesses. Only 55% of Hong Kong SAR businesses use computers. The percentage of Web presence is even lower with only 14% [15].

The Hong Kong SAR government introduced a new multi-application smart identity card to its residents in August 2003. In addition to immigration purposes such as facilitating automated immigration clearance at border control points, a Hong Kong SAR smart identity card includes several non-immigration applications. Residents can now use the digital certificates embedded in their identity cards to update or check personal data kept by the government. With the embedded digital certificates, residents can encrypt email messages, conduct on-line share trading and on-line betting etc. [23]. Residents can use the digital certificate free for one year because the Hong Kong SAR government wants to encourage its people to adopt electronic commerce [32]. By the beginning of August 2004, over 420,000 smart identity card holders have opted for the free digital certificate [22]. This figure equals to around six percent of the population.

A high Internet connectivity rate or even ownership rate of digital certificate does not necessarily lead to individuals' acceptance of electronic commerce. The Finnish government issued a voluntary electronic identification card (EID) to its residents in 1999 [11]. It offered a low-priced digital certificate at 10 Euros to its residents. Nevertheless only ten percent of Finns were willing to pay for the digital certificate. It is unclear how many Finns use the certificates in the end [9]. Given the Finland example, this explorative study aims to investigate how the consumers in Pacific Asia perceive Internet security, how much they know about Internet security, and how ready they are in using digital certificates for electronic commerce transactions.

V. Results

V.1 Demographics

A total of 181 cases were used in the analysis. About two-third of respondents were female and the average age of respondents was 21.7. Furthermore, about two-third of respondents had five to eight years experience of using computer. The mean of Internet experience was 5.46 years. Nearly all respondents had computers at home (96.1%). A breakdown of the demographics of the two samples is shown in Table 1.

Among the 139 Hong Kong SAR respondents, 72% were female and 28% were male. They aged from 20 to 23. The average age was 20.8. Two-third of respondents had five to

eight years' experience of using computer. On average, respondents had 5.3 years experience of using the Internet. Ninety-nine percent had computers at home. Forty-five percent of Australia's 42 respondents were female and 55% were male. The Australian respondents had a wider age range from 21 to 37. About one-third of the respondents aged between 21 and 23. Their average age was 24.79. Similar to the Hong Kong SAR respondents, nearly two-third of the Australian respondents had five to eight years' experience of using computer. The ownership rate of home computer in Australia was slightly lower with only 86%. Yet they appeared to have more experience of using the Internet with an average of 6 years.

Table 1. Demographics of Hong Kong SAR and Australian respondents

Demographic profile	Hong Kong SAR	Australia	Mann-Whitney U-Test	
			Z-value	Sig. (2-tailed)
Sample size	139	42		
Gender				
...Female	100 (71.9%)	19 (45.2%)		
...Male	38 (28.1%)	23 (54.8%)		
...Missing	1 (0.7%)	0 (0%)		
Age			-9.461	0.000***
...Mean	20.8	24.79		
...Min	20	21		
...Max	23	37		
Computer experience			-1.963	0.05*
...Mean	3.73	4.10		
...1-2 years	2 (1.4%)	0 (0.0%)		
...3-4 years	17 (12.2%)	2 (4.7%)		
...5-6 years	51 (36.4%)	12 (28.6%)		
...7-8 years	41 (29.3%)	16 (38.1%)		
...9-10 years	13 (9.3%)	7 (16.7%)		
...11-12 years	5 (3.6%)	2 (4.7%)		
...>12 years	10 (7.1%)	3 (7.2%)		
...Missing	1 (0.7%)	0 (0%)		
Home computer				
...Yes	138 (98.6%)	36 (85.7%)		
...No	1 (0.7%)	6 (14.3%)		
...Missing	1 (0.7%)	0 (0%)		
Internet experience (years)			-2.993	0.003**
...Mean	5.3	6.07		
...Min	2.0	2.0		
...Max	10.0	12.0		

*** significant at 0.001 level; ** significant at 0.01 level; * significant at 0.05 level

Statistical tests were conducted to compare the demographic features of the two samples. As data do not fulfill the assumptions of t-test, Mann-Whitney U test was used. The results of U-test show that Australian respondents were relatively older and had more computer and Internet experience than Hong Kong SAR respondents.

V. 2 Perceptions and knowledge

In addition to providing demographic details, respondents were asked to indicate the following in the surveys in a seven-point Likert scale: 1 indicates none, very insecure or very unlikely; 7 indicates very well, very secure or very likely.

- perception of Internet security
- self-assessed level of knowledge of Internet security
- self-assessed level of knowledge of public key infrastructure (PKI)
- self-assessed level of knowledge of certification authorities (CA)
- self-assessed level of knowledge of digital certificates
- intention to use digital certificate to encrypt emails
- intention to use digital certificate to access Internet banking services
- intention to pay fees to acquire/keep digital certificate

In view of the demographic differences noted above, responses of two samples on Internet security perception and knowledge were reported separately and Mann-Whitney U-test was used to investigate the difference across the two regions. Table 2 shows the comparison results. Overall, there was no significant difference between the two samples in terms of their perceptions and knowledge of the Internet security, and their intentions to use digital certificates. Respondents in both regions have a similar perception of the Internet security and perceived the Internet to be neither very secure nor very insecure (mean=3.83 and 3.55). The average self-assessed knowledge of Internet security in general of the Hong Kong SAR respondents was 3.68 and only one respondent indicated he/she had no knowledge of Internet security. The average self-assessed knowledge of Internet security in general of the Australian respondents was 3.57. The differences between the two regions on Internet perception and knowledge were statistically insignificant.

Table 2. Perceptions and knowledge on Internet security

Items	Hong Kong SAR (mean)	Australia (mean)	Mann-Whitney U-Test	
			Z-value	Sig. (2-tailed)
Perception of Internet security	3.83	3.55	-1.334	0.182
Knowledge of Internet security	3.68	3.57	-0.329	0.742
Knowledge of public key infrastructure (PKI)	2.35	2.86	-1.477	0.140
Knowledge of certification authorities (CA)	2.78	2.86	-0.270	0.978
Knowledge of digital certificates	3.29	2.90	-1.712	0.087
Intention to encrypt emails	3.15	2.71	-1.321	0.186
Intention to use digital certificates to access Internet banking services	3.57	3.83	-0.495	0.621
Intention to pay fees to acquire/keep digital certificates	2.46	2.54	-0.013	0.990

As the two samples showed no significant differences regarding their perceptions and knowledge, further analysis was conducted by aggregating all the respondents (Table 3). Interestingly, respondents' self-assessed knowledge of PKI (mean=2.46) in both regions was much lower than their self-assessed knowledge of Internet security (mean=3.66). Fifty-four Hong Kong SAR respondents indicated that they knew nothing about PKI. Such a discrepancy in knowledge existed also for respondents' self-assessed knowledge of certification authorities and digital certificates. The respondents' average knowledge of certification authorities and digital certificates

were 2.80 and 3.21 respectively. With reference to Table 2, Hong Kong SAR respondents' average knowledge of digital certificates was slightly higher than the Australian counterparts (Hong Kong SAR= 3.29; Australia = 2.90). It is unsurprising that the Hong Kong SAR respondents had a higher average knowledge of digital certificate than the Australian counterpart because more people owned digital certificate in the samples. Nevertheless, such a difference is statistically insignificant.

Most respondents in both regions were not keen to use digital certificates. Although studies have described emails as a killer application for the Internet [20] and most respondents used electronic mails regularly, more than half of the respondents indicated that it was highly unlikely for them to use digital certificates to encrypt email (mean=3.04). Their intention to use digital certificates for Internet banking were slightly higher (mean=3.67). With a mean of 2.48, respondents were unlikely to pay fees to acquire digital certificates.

Table 3. Perceptions and knowledge on Internet security of all respondents

Items	Mean
Perception of Internet security	3.77
Knowledge of Internet security	3.66
Knowledge of public key infrastructure (PKI)	2.46
Knowledge of certification authorities (CA)	2.80
Knowledge of digital certificates	3.21
Intention to encrypt emails	3.04
Intention to use digital certificates to access Internet banking services	3.67
Intention to pay fees to acquire/keep digital certificates	2.48

The Friedman test was then used to further examine the different types of self-assessed Internet security knowledge (Table 4). The results show that the levels of self-assessed Internet security knowledge were inconsistent (Chi-square=129.67). Further analysis shows that both Hong Kong SAR and Australian respondents' self-assessed levels of knowledge of Internet security in general were significantly higher than the others.

Table 4. Within-group comparison of Internet security knowledge

Items	Mean Rank
Knowledge of Internet security	3.14
Knowledge of public key infrastructure (PKI)	1.91
Knowledge of certification authorities (CA)	2.28
Knowledge of digital certificates	2.67
Friedman Test	
Chi-Square	129.67
Significance	0.000***
*** significant at 0.001 level	

Likewise, the Friedman test was used to examine respondents' intentions to use and acquire digital certificates (Table 5). The results show that respondents' intentions were inconsistent. Respondents were more likely to use digital certificates for Internet banking instead of email application. More importantly, their intentions of using digital certificates were higher than their intention to acquire the certificates.

Table 5. Within-group comparison of intentions

Items	Mean Rank
Intention to encrypt emails	2.02
Intention to use digital certificates to access Internet banking services	2.30
Intention to pay fees to acquire/keep digital certificates	1.68
Friedman Test	
Chi-Square	29.135
Significance	0.000***
*** significant at 0.001 level	

As this is an explorative study, we also examined the correlation among respondents' different perception and knowledge measurement items. Results of Spearman's Rho indicate that respondents' perception of Internet security was not related to their levels of knowledge and was only slightly correlated with their intention of using digital certificates for Internet banking. Nonetheless, their intentions to use digital certificate was significantly correlated to their levels of knowledge in Internet security.

VI. Discussions and Conclusions

In summary, the results of the study show that respondents were unsure how secure Internet is. Moreover, their self-assessed knowledge on Internet security was relatively low. In a Likert scale of 7, their lowest means of self-assessed knowledge was only 2.46. Similarly their intentions to use digital certificates were low with means between 3.04 and 3.67. Comparisons of two groups show that other than demographic differences, there was no significant difference between the two samples in any measurement item. That is, respondents in both regions have similar level of e-literacy and readiness to use digital certificates.

Further data analyses indicate that the self-assessed knowledge of several key concepts relating to Internet security (PKI, CA and digital certificates) of respondents in both Australia and Hong Kong SAR was significantly lower than their self-assessed knowledge of Internet security as a whole. Such inconsistency raises an interesting question: did consumers in Australia and Hong Kong SAR really know about Internet security or did they over-estimate their understanding? While one may argue that such overconfidence phenomenon is unsurprising, so far no empirical data was provided by any existing research to prove it.

Similar inconsistency was found over their intentions to use and acquire digital certificates. While the means of intention to use digital certificates were between 3.04 and 3.67, their intention to pay fees to acquire or keep digital certificate was significantly lower (mean=2.48). Results indicate that respondents might have intentions to use digital certificates, but they were not interested in paying fees to acquire the certificates. Although the residents in Hong Kong SAR will be given free certificates, they were as unlikely as their Australian counterparts to use the certificates. Results also suggest that between the two types of digital certificate application, respondents were more

likely to use digital certificates for Internet banking and did not concern much about confidentiality of their emails.

The results of the study are useful to Internet vendors as they reflect the level of e-literacy and consumers' intentions to use digital certificates in Internet transactions in Pacific Asia. Consumers need not be experts in Internet security but a basic understanding is necessary [16]. As respondents in both regions were university students, one may argue that generalization of conclusions should not be extended beyond this particular group of consumers. Nonetheless, being the "elites" of societies, if university students do not understand the concept of Internet security, how likely is it for the other consumers to understand it? As results indicate that respondents had low intention to pay for digital certificates, we recommend that if governments want to encourage e-commerce, they should provide free digital certificates to their residents. Moreover, results show that consumer's knowledge of Internet security is significantly related to their intentions to conduct Internet transactions. We recommend that in addition to promoting more digital certificate applications, governments should provide more education on Internet security to residents. People other than security professionals or students who major in computer science or information systems should have opportunities to learn about this topic. By understanding what digital certificates are, how they work and their pros and cons, consumers may be more willing to engage themselves in electronic commerce. With regard to further research in this area, researchers may consider developing a conceptual model and examine the interrelations among consumers' perception, knowledge and intention.

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Using the Balanced Scorecard to Evaluate the Value of Information Assets in Security Risk Management of Medical Care

Bo-Jie Juang & Hung-Wei Lin
Institute of Healthcare Information Management
National Chung Cheng University, Taiwan
168, University Rd, Min-Hsiung Chia-Yi, Taiwan, R.O.C.
TEL: 886-5-2721500, FAX: 886-5-2721501
Sam.liondance@gmail.com

Abstract: Information technology has been widely applied in the fields of globally medical care, which makes the service apparently progress in its quality and efficiency. However, medical information that was stored in electronic form really causes the risk of leaking.

A good security risk management offers a positive guarantee for hospitals, which highly relying on information technology, while running their organization.

While carrying out risk analysis, the value of information assets, existing weakness, and potential threat from outside of this information system must be realized. It is quite important to determine the value of information assets for the security risk management.

With information age coming, there is the greater part of asset value not shown from the traditional balance sheets in accounting books. This kind of asset, which can't be shown on the balance sheet, is intellectual capital. In the study of information asset and intellectual capital, Ross et al. (1996) divided information assets into three kinds of capitals - human asset, technology asset and relationship asset. These play the same tune with the three key elements of intellectual capitals- human capital, structural capital and relational capital. Within numerous assessment methods of intellectual capital, balanced scorecard assesses intellectual capital value from the view of management and efficiency.

Hence, this research proposes utilizing the balanced scorecard to find out the assessment index of information assets for domestic medical institutes while carrying on risk management. Hopefully, the results of this research can be regarded as the references of risk management of information security for domestic medical institutes.

Keywords: Internet Security and Privacy.

I. Introduction

Hospitals are indispensable in the social, and undertake the first line rescue of health and safety. Therefore, there are many hospital requests that come from the law and the society from all walks of life. The biggest difference between hospitals and other professions service is that medical service matters person's health and the life and death. A slight mistake or a fault may bring about a regret

that is irrevocable or unable to make up. Therefore, hospitals and other general organizations have the enormous difference in the processing service and decision-making.

Information technology has been widely applied in the fields of globally medical care, which makes the service apparently progress in its quality and efficiency. However, medical information that was stored in electronic form really causes the risk of leaking. That's why people care most about rights of privacy after the electronic medical record was brought into practice. Also, legislation and the promotion of electronic medical record are influenced by this factor but not problems from technology (Dye, 1986; Hall & Rich, 2000) .

The United States formulated HIPAA (Health Insurance Portability and Accountability Act) in 1996. It was from the legal stratification plane to establish the right of privacy protection standard that can be observed by hospitals. In Taiwan, The Department of Health (DOH) has established a working group of "the medical information security and the privacy protection guiding principles" in order to strengthen patients' medical information security and the privacy protection. The working group has drafted "the medical information security and the privacy protection guiding principle".

After looking at the domestic and foreign laws and regulations, it can be understood that information security is very important for hospitals. The overseas government and the medical system none who does not devote to patients' electronic data security and the privacy protection hoped to formulate each kind of laws and regulations to make the medical system observe the protection standard. Because of the laws and regulations restrictions, hospitals must start to plan ISMS for each information security request. Risk management plays a critical role in protecting an organization's information assets. An effective risk management process is an important component of a successful IT security program. Therefore, the risk management process should not be treated primarily as a technical function carried out by the IT experts who operate and manage the IT system, but as an essential management function of the organization. (Stoneburner, G., A. Goguen, et al., 2002) .

Risk management includes two major parts - risk analysis and risk control (Boehm, 1991). While carrying out risk analysis, the value of information assets, existing weakness, and potential threat from outside of this

information system must be realized. It is quite important to determine the value of information assets for the security risk management, because the more indefinite the value of information assets in the organization is, the harder to realize which asset is so worthy and important that needs special protection or even being reduced or shifted its risk; or, with limited resources, the risk is acceptable because the value of the asset is low. Besides, managers of the organizations often rely on the value of the assets to determine the investment of information security. Now, there is not a standard measurement index to assess the value of information assets in the relevant information security management standards.

Hence, this research proposes utilizing the balanced scorecard to find out the indicators of information assets assessment for domestic medical institutes while carrying on risk management. The importance of each kind of information assets must be confirmed through the assessment indicators. The results of this research can be regarded as the references of risk management of information security for domestic medical institutes.

II. Information Security

The so-called information security is to apply the management and the technology to hardware, software and data. It avoided other people to read, add, delete and modify storing or transmitting data. The rigorous level of information security management and the precise level of technology were decided by the risk which information was exposed under the procedure or the technique.

Other definitions of information security were collected in table 1:

Table 1. The Definition of Information Security

Name	Year	Content
Eloff and von Solms	2000	Data or information system still conforms to the security demand after passing through a series of test.
Finne	1997	Information security means a number of measures taken to minimize the risks connected to information.
Schultz, Proctor, Lien and Salvendy	2001	Information security in its most basic sense is protecting computer-related assets such as computers, networks, data, programs, and the hardware components.
Parker	1997	Information security is concerned with information protection that includes individual conversation, printing files and automated records.

(Source : My reorganization)

Icove (1,995) thought that the generalized computer security contained several constructions:

- **Physical Security** : the protection of computer facility. Physical security avoids stealing and destruction of these facilities. Physical security also guarantees the computer facility against the natural disaster and all damage that is made by other environmental factor.
- **Personnel Security** : personnel security covers

widespread scope, promoting computer security is one goal of strengthening personnel security. The goal of personnel security is to prevent personnel's security threat. It is an important part of personnel security to investigate personnel's background and monitor the operations.

- **Communication and Data Security** : the goal of communication and data security is to protect data transmission security ,including mail, telecommunication, facsimile and Internet. Internet is in fashion; communication and data security already became one of projects that the enterprise should specially pay great attention to.

- **Operations Security** : the goal of operations security is to prevent the compute crime, and raise attention to the computer crime.

The following figure shows the concept of computer security that was proposed by Carroll.

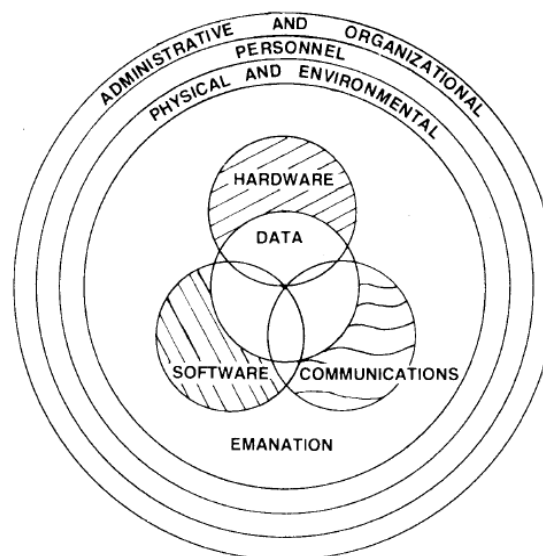


Figure 1. The Concept of Computer Security (Carroll,1987)

The technical tradition security concerning IT and information is typically defined by three aspects; confidentiality, integrity and availability (Gollman, 1999; Harris, 2002; Jonsson, 1995) .

Gollman (1999) define CIA as follows:

- **Confidentiality**: Prevention of unauthorized disclosure or use of computer systems and data
- **Integrity**: Prevention of unauthorized modification of computer systems and data
- **Availability**: Ensuring authorized access of computer systems and data when required

The definition of information security management which was proposed by Russell and Gangemi (1992) is that, "The information security management is to protect all things related with computer security, including computer, software, data, terminals, printers, tapes, disks, even the computer rooms." Consequently the managing of

information security should differ between organizations (Mintzberg 1983, Baskerville 1993).

Various authors (e.g., Siponen and Baskerville, 2001; Straub and Welke, 1998; Baskerville, 1993, Hitchings, 1995) suggest that the major problem with current approaches to managing IS security relates to the technical orientation of the solutions. They argue that the social and organizational aspects should be more considered in managing information security.

A good security risk management offers a positive guarantee for hospitals, which highly relying on information technology, while running their organization.

There is a discussion of the hospital information security problems in the following section. The first hospital information security problem is about internal personnel. Before computerizing, patient records in paper form had to prevent the natural disaster and stealing. Although now electronic patient record has been developed. It is still a big threat for internal personnel stealing. (Ross, 1996)

Software bugs and hardware failures occasionally corrupt messages. While mail, fax and telephone systems also fail, their failure modes are more evident than those of computer messaging systems. With poorly designed software, the figure could be substantially higher. (Ross, 1996)

Viruses have already destroyed clinical information, and a virus could conceivably be written to make malicious alterations to records. (Ross, 1996)

A malicious attacker might also manipulate messages. Sending email, which appears to come from someone else, is easy, and with some more effort it is possible to intercept mail between two users and modify it. (Ross, 1996)

By the literature, information security actually works in many ways, it involves technology, management even involves to policy, and legislation and so on, if everything get prepare in advance, many persecutions might be eliminated in the future.

III. Security Risk Management

Each industry has its unique commercial risk. In medical care industries, the commercial risk is patient safety, PHI and the right of privacy. Therefore, hospitals need the risk management. Besides IT risk assessment, hospitals also need the enterprise risk assessment to guarantee each person's responsibility. (Louis J. Carpenito, 2004)

Once the enterprise decides to establish the ISMS, the steps of risk management are inevitable. Generally speaking, the steps of risk management may be divided into the following four steps.

I. Identification and Recognition

II. Measurement and Evaluation

III. Selection Risk Management Techniques

IV. Implementing and Evaluation

Proper risk assessment planning is critical to the success

of the entire risk management program. Assessing risk requires cross-group interaction and for different stakeholders to be held responsible for tasks throughout the process. A best practice to reduce role confusion throughout the process is to communicate the checks and balances built into the risk management roles and responsibilities. While you are conducting the assessment, communicate the roles that stakeholders play and assure them the Security Risk Management Team respects these boundaries. The following table summarizes the roles and primary responsibilities for stakeholders in this phase of the risk management process.

Table 2. Roles and Responsibilities in the Risk Management Program

Role	Responsibility
Business Owner	Determines value of business assets
Information Security Group	Determines probability of impact on business assets
Information Technology--Engineering	Designs technical solutions and estimates engineering costs
Information Technology--Operations	Designs operational components of solution and estimates operating costs

(Source : The Security Risk Management Guide)

Business Owners have explicit roles in the risk assessment process. They are responsible for identifying their organizational assets and estimating the costs of potential impacts to those assets. Most information security professionals and non – technical stakeholders do not realize this connection automatically. Business managers often rely on the value of an asset to guide them in determining how much money and time they should spend securing it. At present, the methods of estimating the value of information assets are subjective. No objective tools or methods for determining the value of an asset exist.

IV. Information Assets and Value Estimate

The enterprise assets may be tangible or intangible. Both needs to be defined explicitly, business owner can explicitly estimate the value. The value of information assets is based on the impact degree to the organization. From the viewpoint of information security, the asset classification and the control are so important in the risk assessment.

The IT service combined tangible assets with intangible assets. Organization can first handle the most essential assets after the information asset classification has been done. Generally speaking, the information assets can be divided into five categories. The proportions of these five categories are not the same in different business projects, workflows, organization characteristics and culture. (Alberts, et al., 2003)

Security requirements outline the qualities of information assets that are important to an organization.

When the security requirements of an asset are violated, certain outcomes are possible (outcomes are directly related to security requirements in the table below).

Table 3. Relationship of Security Requirements to Outcomes

Security Requirement	Outcome
Confidentiality	● Disclosure of asset
Integrity	● Modification of asset
Availability	● Destruction of asset
	● Loss of asset
	● Interruption of asset

(Source : Health Information Risk Assessment and Management)

Asset values are based on the impact to the organization if the asset is lost. For some tangible assets, standard accounting procedures or replacement costs can be used. Acquired value for intangible assets can be estimated based on the loss to the enterprise. (Hutt, et al., 1995) The traditional measure of an asset is in terms of dollars. Reducing all assets to dollars makes for an easy comparison, and people are often comfortable thinking in terms of dollar values for assets. It can be very difficult, however, to reduce some intangible assets to dollar values. The cost of estimating statistically can be high in some cases, and statistical estimates may depend on subjective assumptions. Historical data, if available, can be useful in estimating the value of assets. In many cases relative rankings of asset values are sufficient. (Fites, et al., 1989) One way to estimate the value of assets is to consider what would happen if their security requirements were violated. Let's consider an example in which a medical center wants to protect its patient records. Staffs are concerned about the possibility of disclosing the patient records because this would violate the security requirement that sensitive information must remain confidential. If the information is disclosed to an unauthorized party, the fact that the information is no longer confidential has an impact on the organization. If the impact affects private medical diagnostic results or treatment plans, the value of the asset would be extremely high. On the other hand, disclosure of staffing assignments for nursing shifts, for example, might not have a serious impact on operations, so the asset value would be low. (Alberts, et al., 2003)

With information age coming, there is the greater part of asset value not shown from the traditional balance sheets in accounting books. This kind of asset, which can't be shown on the balance sheet, is intangible asset. It is also called intellectual capital. According to literature, intangible asset has taken the majority of the whole value in the software and IC industries.

The suggested measuring approaches for intangibles fall into at least four categories of measurement approaches. The categories are an extension of the classifications suggested by Luthy (1998) and Williams (2000).

- ✧ **Direct Intellectual Capital methods (DIC).**
- ✧ **Market Capitalization Methods (MCM).**
- ✧ **Return on Assets methods (ROA).**
- ✧ **Scorecard Methods (SC).**

The methods offer different advantages. The methods offering \$-valuations, such as ROA and MCM methods are useful in merger & acquisition situations and for stock market valuations. They can also be used for comparisons between companies within the same industry and they are good for illustrating the financial value of Intangible assets, a feature, which tends to get the attention of the CEOs. Finally, because they build on long established accounting rules they are easily communicated in the accounting profession. Their disadvantages are that by translating everything into money terms they can be superficial. The ROA methods are very sensitive to interest rate and discounting rate assumptions and the methods that measure only on the organization level are of limited use for management purposes below board level. Several of them are of no use for non-profit organizations, internal departments and public sector organizations; this is particularly true of the MCM methods. The advantages of the DIS and SC methods are that they can create a more comprehensive picture of an organisation's health than financial metrics and that they can be easily applied at any level of an organisation. They measure closer to an event and reporting can therefore be faster and more accurate than pure financial measures. Since they do not need to measure in financial terms they are very useful for non-profit organisations, internal departments and public sector organisations and for environmental and social purposes. Their disadvantages are that the indicators are contextual and have to be customised for each organisation and each purpose, which makes comparisons very difficult. The methods are also new and not easily accepted by societies and managers who are used to see everything from a pure financial perspective. The comprehensive approaches can generate oceans of data, which are hard to analyse and to communicate.

In Scorecard methods, one method is balanced scorecard. It belongs to the non-dollar method. Kaplan & Norton proposed this method in 1992. They proposed the concept of balance scorecard because enterprise's performance measurement and the strategy management should not only consider the financial aspect in new environment. It is an ideal way to contain company's intangible asset. This may make up the insufficiency of financial accounting. This idea is the same as asset value estimate in security risk management.

Within numerous assessment methods of intellectual capital, balanced scorecard assesses intellectual capital value from the view of management and efficiency. Many enterprises declared that they had already applied the balanced scorecard. Its performance measurement has covered the finance and the non-finance index. Such system is more balanced than the financial system.

The balanced scorecard includes four constructions to measure organization performance. The concept of balanced scorecard is suitable for the value estimate of intangible assets.

The balanced scorecard is used in the healthcare

institutes initially, but some articles had described the use of balanced scorecard in the healthcare environment and its potential benefit.

The healthcare institutes that have used the balanced scorecard consider the difference between BSC and other systems:

- The majority of measuring approaches were only suitable in partial management, clinical and diagnostic functions.
- Other measuring approaches were unlike BSC to provide leading indicators.

BSC can be used to express the strategy complexity and the interaction relations through the linkage of causal relations. The information of cost, quality and workflow can be easily and clearly exchanged.

V. Conclusions and Future Work

The enterprise assets may be tangible or intangible. Both needs to be defined explicitly, business owner can explicitly estimate the value. The value of information assets is based on the impact degree to the organization. From the viewpoint of information security, the asset classification and the control are so important in the risk assessment. The traditional measure of an asset is in terms of dollars. But balanced scorecard is different to the traditional method. It belongs to the non-dollar method. The concept of balance scorecard is that enterprise's performance measurement and the strategy management should not only consider the financial aspect in new environment. It is an ideal way to contain company's intangible asset. This may make up the insufficiency of financial accounting. This idea is the same as asset value estimate in security risk management.

The balanced scorecard is used in the healthcare institutes initially, but some articles had described the use of balanced scorecard in the healthcare environment and its potential benefit. Hence, this research proposes utilizing the balanced scorecard to find out the indicators of information assets assessment for domestic medical institutes while carrying on risk management. The importance of each kind of information assets must be confirmed through the assessment indicators. And the results of this research can be regarded as the references of risk management of information security for domestic medical institutes. Hospitals can use security risk management to take appropriate control, to reduce, to prevent, and to change its commercial risk. Then the hospital operation could be continuing.

It is a convenient and effective solution to use the electronic medical information for improving the quality of medical service. Hospitals can avoid the repetition and the waste of medical resources. They can achieve the purpose of saving the medical cost through the connectivity and the exchange of the electronic medical information.

Although there are many merits for using the electronic medical information, however, it still has the information

security problems such as data integrity, confidentiality, non-repudiation and identification. How to obtain the balance in reasonably using the electronic medical information and in protecting patients' privacy is a important issue that should be paid attention to when planning the electronic healthcare information service.

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Integrated Multilevel Intrusion Detection and Report System

Tung-Shou Chen^a Puo-Iang Chen^b Tian-Shing Wang Yung-Hsing Chiu Sheng-Li Lai
Graduate School of Computer Science and Information Technology
National Taichung Institute of Technology
tschen@ntit.edu.tw^a tejiro0826@yahoo.com.tw^b

Abstract: In this paper we demonstrate a new impression of intrusion detection system. We use multilevel structure of intrusion detection systems to protect our network. Most of traditional report systems are complicated and hard to manage. In our system, our interface of report system is easy to read and manage. The most important is we use open source software to integrate our system. This can make the cost of intrusion detection system down and make our system flexible. It is convenient to user and network manager. In our system, we can integrate different intrusion detection system and report system into one system. It will become a trend nowadays.

Keywords: intrusion detection system (IDS), firewall, report system

I. Introduction

In recent years, the development of internet become more and more important, and made life convenience. Internet is usually used for research or the way to find information what you need in early years, so researchers are the main users of internet before. Internet is a versatile tool for people nowadays. We can send and receive E-mail, browse website, or find other information related our life in internet. Especially E-commerce, Internet has turn into important tool for modern people.

The conveniences of internet include information exchange and business transactions in internet. The rapid development of E-commerce gives the credit to internet because of its transmitting information is fast. Popular of internet also brings lots of security problems. We should pay much attention to security of E-commerce especially for enterprises. These security problems become important issues today. Most of enterprises use firewall to protect their data and network. But it is not enough. Problem of hacker attack becomes more and more changeable, and various types of virus and troy are increasing. The most important thing is the problem of artificial careless mistake. The security problems of enterprises network come form inside network of enterprises. Network security is hard to defend. Protecting network cannot bear using in the single firewall. For guarantee the security of information and electric business trade, it is indispensable to have an intact and convenience network protect structure.

The prevailing of e-commerce makes enterprises to pay

more and more attention in network security. Some enterprises think that is enough for network security to set up only firewall. But this is incorrect. Firewall only can be a basic network protection. The main function of firewall is to control who want to get into network. However, enterprises still have security problems with only set up firewall. In E-commerce, network packages represent all kinds of trade information. If enterprises cannot ensure the security of network safe, it will cause great money to lose by a small security problem. A simple network attack may cause millions dollars losing for enterprises. Furthermore, it will cause customer information or commercial materials outside of enterprises. Then the goodwill of this enterprise will be seriously injury. Hence, for E-commerce issue. Network security should be care seriously. Besides important of firewall in this issue, intrusion detection system is another important issue in our research.

Intrusion detection system as call IDS is a critical tool of network security. It has much capability, include of sniffing and checking network packages and generate alert log files when it detects network attack. Network structure that only has firewall is not tight enough. For this reason, the integration structure of firewall and instruction detect system turn into safer network security system.

What is the main difference between firewall and intrusion detection system? The mainly purpose of firewall is to identify different IP address and to open up server services for network outside. But the mainly purpose of intrusion detection system is to sniff packages and to detect suspicious packages. If we image that internet is an important road. Firewall looks like a traffic-police on this road. It determines whether you drive against traffic regulation or not, and it can also to fine you when you against traffic regulation. Intrusion detection system looks like a camera of testing speed on the road. It can take down cars which against traffic regulation and then convey car information for traffic-police. The disadvantage is that cannot find the car which against traffic regulation. And this is the largest different between firewall and intrusion detection system. In our research, we present a structure to integrate them.

Commonly intrusion detection system has some disadvantages. They are miscellaneous alert messages and commercialized intrusion detection system is too expensive and hard to maintain. Some of free intrusion detection systems have shortcoming with insufficient. And most important is that when you get alert messages or log files from firewall or intrusion detection system, these reports are uniform. The shortcomings of these reports are hard to read

and have no idea to alter according to user's demand. Even intrusion detection system or firewall is strong, and the reports from these places have no idea to let users or MIS understanding immediately. It conveys more trouble to maintain system and to protect network for MIS or users.

In order to solve illegal network connection and network attack. In our research, we introduce a multilevel network security structure. We call it Multilevel Network Security Structure (MNSS). In this structure, we clean up insufficient security of only firewall in network structure. And offer multilevel of network protection. The structure of our research is including firewall, intrusion detection system, and report system. Our system presents a high stability, high expending with high capacity and efficiency, and easy to management. The best advantage is to make the whole system cost down. These advantages will be introduced in following paragraphs.

In MNSS, we also present a personal report system (PRS). This report system differs from other common report systems, it can add and delete report column according to user's requirement. Our report system will generate new report form according to user's requirement. It can also generate report according to different position of company. For example, leader of enterprises usually wonder to know whether the company meets a great network attack or not. He does not want to know every alert message in peacetime. Our report system can generate reports which boss interesting at the time. Our report system conveys convenience to most of MIS.

We will introduce MNSS and Personalize report system in detail in following chapters. Chapter 2 will introduce preview of intrusion detection system and its advantages and disadvantages. And intrusion detection system used by our research briefly. Chapter 3 will introduce system structure in detail. Chapter 4 is experiment. And last chapter is conclusion.

II. Preview

II.1 The Category of Intrusion Detection System

There are two categories of intrusion detection system. One is Host-based Intrusion Detection System (HIDS), and the other is Network-based Intrusion Detection System (NIDS). NIDS is typically used recently. Most of researches like to study NIDS which has flexibility used. In our research, we also use NIDS to develop our work. The intrusion detection system is divided into two parts, abnormal detection and misuse detection [1] [2]. We introduce in following briefly.

II.2 Abnormal Detection

Technique of this part is to analyze user behaviors and to use this information to find out whether this is normal used behavior. This method uses user behavior information which collects in advance to determine behavior normal or not. The algorithms of statistic and mathematical induction are used in this part of detection technique mostly. Importance of this

technique is how to define a normal and correct user behavior. The data for defining user behavior also influence user behavior or not. The advantages of these detection techniques are learning automatically. This function can prevent network attack which did not used before. The disadvantage of this technique is depending on user behavior which is collected to define normal model correct or not. If attacker attacks network by using normal user behavior define before, this technique does not find out this behavior correct or not. We will show these detection techniques of abnormal detection as following.

II.3 Neural Network

Neural Network (NN) has capacity of using a large number of data to train these data and learning from training data. There are more and more different applications for researcher in this technique [3]. So this technique also is used for one of intrusion detection system to detect user behavior.

II.4 Support Vector Machine

Support Vector Machine (SVM) and NN are from technique of artificial intelligence. This technique can also predict user behavior by training data set. Some researchers use this technique on intrusion detection system [4] [5], too.

II.5 Data Mining

Algorithms of data mining also apply to collect data and analysis data by some researchers before [6]. This technique can make new feature recognize rule to protect network. Hence, this intrusion detection technique has much security of network.

II.6 Statistical Algorithm

This kind of detection is similar to data mining method. This technique analyzes data collected to calculate a normal user behavior model by using statistical algorithm. The advantage of this technique is that you should understand statistic seriously in advance. And you must use complex mathematic to calculate final result.

II.7 Misuse Detection

The detection technique of misuse detection uses rule-base detection to define network attack. Defined rules will store in database. Intrusion detection system uses rule in database to analyze network package. Pattern matching is one of commonly used technique in this detection. Pattern matching applies on most of intrusion detection system. It has high detection rate on this technique. This technique can use network attack known by pattern matching rules in database. If system detects attack from network, it sends alert message to user or other protect system. User can understand what kind of attack happens through alert message. And user or system manager can defend this attack by information from alert message.

The key point of this technique is that we should collect large number of network attack already know to build

database. So system manager can use rules in database to match with network packet and find out is it network attack. However this technique cannot defend network attack by learning from expensive.

Some researcher used System Call to apply on intrusion detection system before [7]. Most of intrusion detection system mainly uses misuse detection to develop their system. Because of detection technique with pattern matching makes detection faster and convenience. And it has higher detection rate. Some of researchers work for combining abnormal detection and misuse detection into one system.

In our research, we use a commonly used freeware – Snort to be our intrusion detection system in our system. Our research uses iptable to be firewall in our system. We also use ACID to modify our report system, and it is called personal report system. We choice Analysis Console for Intrusion Database (ACID) to modify our system because of it can deal with the report from Snort and iptable. That is why we use these softwares to integrate our system.

Snort is a generally used intrusion detection system today. It has more resource internet. In the part of updating version is very fast because of it is open source software. So that Snort is a powerful and high security intrusion detection system. We will introduce Snort briefly as following.

II. 8 Snort

Snort is a real-time intrusion detection system developed by Martin Roesch. Snort is a lightweight Network-base intrusion detection system. It means when intrusion detection system detects package from network. It does not effect network overloading. Snort has lots of advantages. Snort is cross platform software. And it can work on Linux and Windows. There are three modes of snort. They are Sniffer Mode, Packet Logger Mode, and Network Intrusion Detection System Mode.

1. Sniffer Mode: This mode is used to sniff network

package.

2. Packet Logger Mode: Recording network package information.
3. Network Intrusion Detection System Mode (NIDS Mode): Analyzing network package, and detecting package from network by rule database.

Snort uses NIDS Mode to start intrusion detection, and the structure of intrusion detection shows on Fig. 1. There are four parts of structure of snort. They are Packet Decoder, Preprocessor, Detection Engine, and Output Stage. We introduce these parts first.

1. Packet Decoder: This part collect package from network. It copy broadcast package from network. And it will decode packages which collect from network. Decoded package will be sent to Detection Engine.
2. Preprocessor: This part mainly preprocess package from network. And it can increase detection rate and process speed. Snort provides eight preprocessors at present. Each preprocessor has different function. These preprocessors can choice by user requirement.
3. Detection Engine: Snort used brute force algorithm to do pattern matching in the early. But this algorithm costs much time and resources. Therefore, Snort provides a new algorithm to do pattern matching - Boyer-Moore pattern matching now. This algorithm saves much time than brute force algorithm. For speeding up time of pattern matching. Snort uses three-dimensional linked list data structure in detect engine. These functions make Snort more convenient and efficiency.
4. Output Stage: Output stage decides whether sends alert message or not according to detect engine. So that can generate log files or send alert messages to report system.

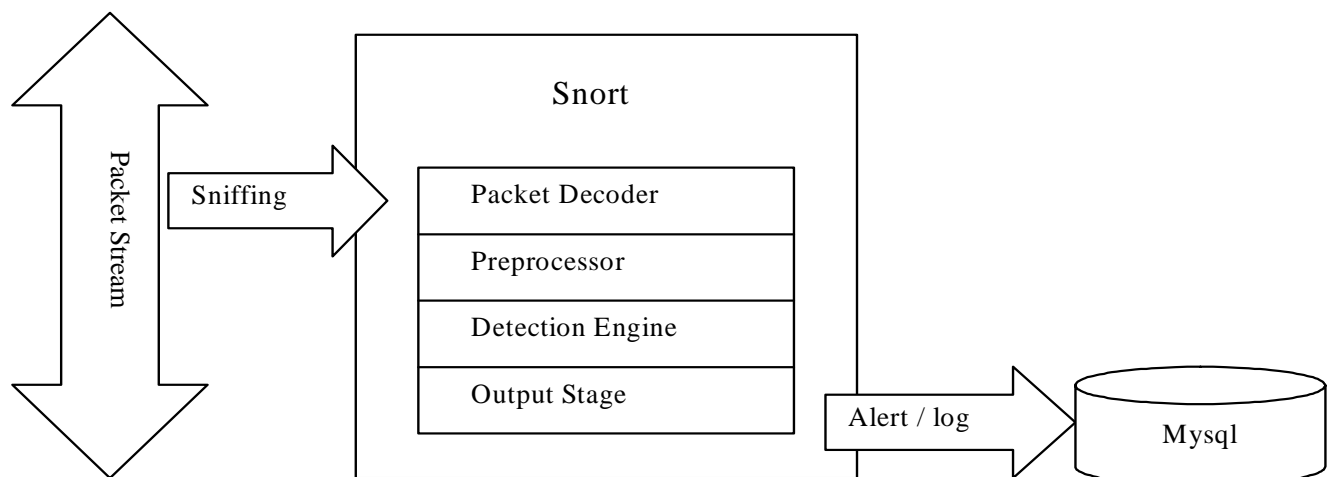
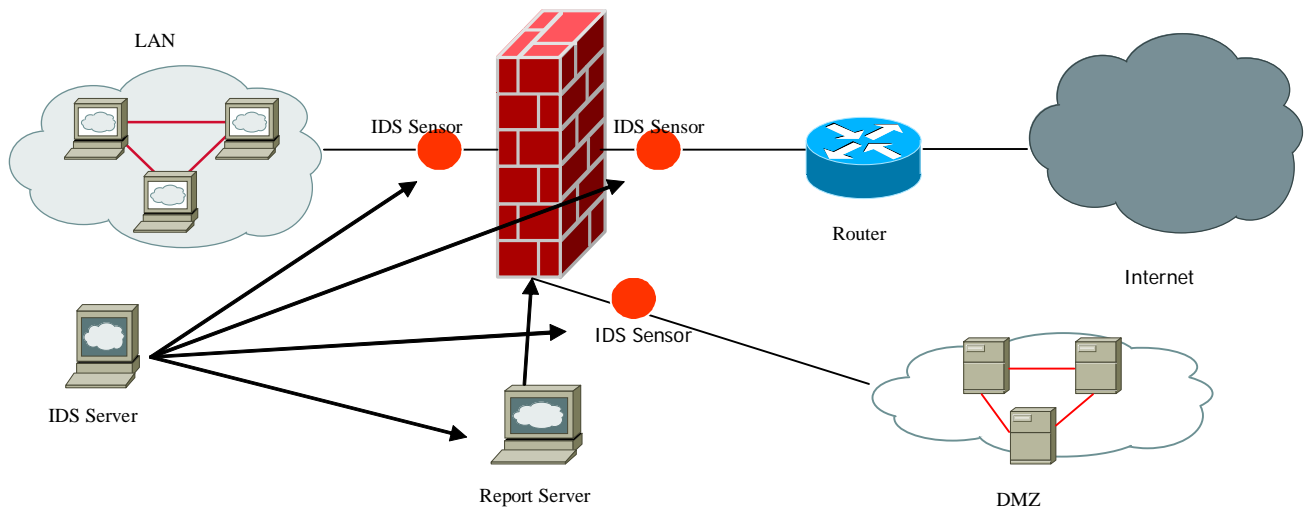


Fig. 1 Structure of Snort



2: System Structure

III. System Structure

Almost Network security systems only use firewall to do network protection before. This structure seems safe enough to general users. But it is danger for enterprises and some e-commerce of company. Hence intrusion detection system is developed for this reason. Most of companies use firewall and intrusion detection system to protect their information on network. It is a trend to use more than two different function systems to protect important information. There still has a problem in user confused of how to build a safer network environment. In our research, we provide a structure to solve this question. We use multilevel network structure for network security system. We find out most of problem from security issue happened before. We present an overall structure for network security. Such as most security problems are from wide-area network (WAN). So we set a sensor in WAN in order to collect information of WAN. In our research, we will set security measure on places where may occur security problem. In the following, we will introduce this structure detail on this chapter.

III. 1 Multilevel Network Security Structure (MNSS)

In order to solve problems mentioned pro paragraph, our research presents a structure call Multilevel Network Structure (MNSS). We integrate firewall, intrusion detection system, and report system into our structure. System structure will be shown in Fig 2.

Intrusion detection system sets three sensors on our structure. They are set in DMZ, in front of firewall (LAN) and behind firewall (WAN). The function of sensor in front of firewall (LAN) mainly checks whether someone attacks network or not. The function of sensor behind firewall (WAN) is to monitor attacks in wide-area network. Final, sensor in DMZ is to ensure servers are safe enough.

Therefore, we set every place where may be attacked by hacker or someone to ensure our structure is safe enough. This structure ensures that it cannot lose any probably attack by someone. And we also know where attack is happened through our structure.

The main advantage of intrusion detection system is this technique does not cause overloading of network. Because of intrusion detection system only sniffs network. Intrusion detection system was an assist tool for firewall to protect network before. Hence, when network attack comes from WAN or DMZ, the system does not know where attack is. So system does not send alert message to user or system manager in real-time. That is why we set three sensors in our structure.

The special of our structure is that we have an independent report system. We call it personal report system (PRS). PRS will introduce in later.

In our research, we use Snort, iptable, PRS to build our structure. Hence, the sensor in front of firewall is first line of defense in our network. Second is firewall. If attack appears in WAN, sensor behind firewall can find out it. Finally, PRS can tell user or system manager where attack occurs, so system manager can handle the situation. That is why we call it multilevel network structure.

In our research, all of systems in our structure are open source software, such as Snort, iptable, PRS. Properties of open source software are free, flexible, and maintain easily. Therefore, MNSS does not necessarily to use the same software which are using in our research, it can be changed into other software according to user's custom and requirement. In other words, the sensors also can replace with three different intrusion detection systems. It can make network security more faultless.

III. 2 Reduce System Cost

Intrusion detection system makes people condemn mostly

because of its expensive software price. Stable and multi-function security system should be bought from company who provides network security service. To enterprises, they should cost much money on building a security system when e-commerce develops in initial stage. This is whole enterprises worried.

Our research makes network security safer and cost down. And our research uses open source software to build system. Open source software is easily to learn because of its network resources. Document and software information is easy to get. In opposition to commercial software is hard to use and learn. And information of commercial software is hard to get. Using commercial software is a burden for system manager. MNSS allows user to choice different intrusion detection system and firewall according to their need, and it can make system cost down.

We also have a special capacity that when someone attack network in MNSS. This capacity can handle network attack real-time by user setting. It reduces time of dealing with network attack by system manager. MNSS can monitor 24 hours to save labor power and cost consume.

III. 3 Independent Report System

In our research, we separate report system to independent server. In commonly security system, intrusion detection system and report system are usually in one server. It cause intrusion detection system and report system cannot work when server down. At this moment, there is only firewall work in security structure and increasing danger in network.

In our structure, report system still work when server down. And report system can centralized manage log files and alert messages from intrusion detection system and firewall in order to avoid server overloading. The other advantage is report system still work when intrusion detection system and firewall change.

III. 4 Personal Report System (PRS)

Our report system calls personal report system (PRS). The system modify from ACID and system structure show in Fig. 3. PRS will introduce as following detail.

PRS uses SMNP protocol to receive log files and alert messages from intrusion detection system and firewall to centralize management. It preprocesses log files and alert messages and saves it to database. Our PRS provides a friendly user interface. This user interface lets user to set report column they need and save it. Database will receive information of which column user selected and send these columns to PRS. PRS uses these data from database to generate report, so we call it personal report.

PRS can generate different reports according to user's requirement. It makes user more convenience. PRS also can generate report base on different positions in company. Leader in company or department only wants to know serious attack about network security. Traditional report system generates only one or few format report for user reading. Leader in company does not want to see these reports. It is too long and complex. PRS does not have these

questions. It can make a great help and save lot of time to system manager.

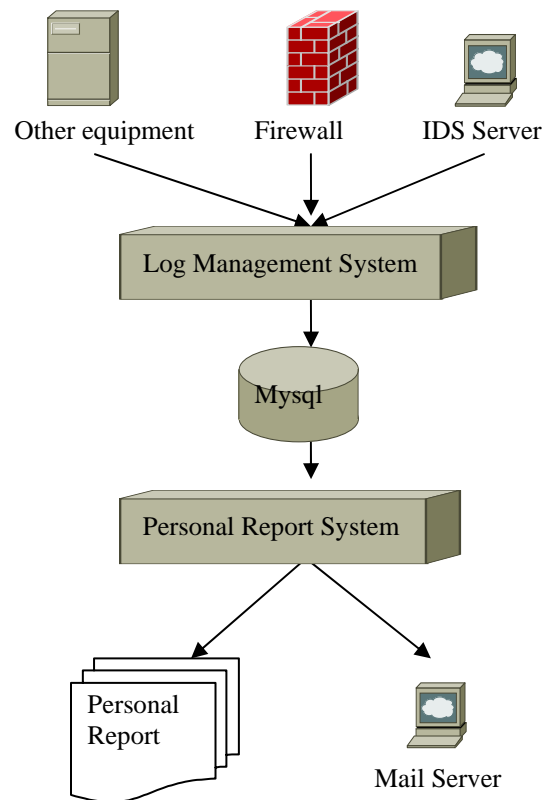


Fig.3 Personal report system structure

IV. Experiment and Analysis

Capacity of defend serious attack

Intrusion detection system must monitor network 24 hours continuously when MNSS is working. In the process of monitoring network, MNSS may detect an obvious network attack. Intrusion detection system only monitor network when network attack occurs before. Network security only uses firewall to defend, and it brings more burdens on firewall. And it must control by system manager. These situations make firewall and system manager more and more trouble.

Our structure has a capacity of defend obvious attack. It can detect and defend obvious attack from network immediately. The flowchart shows in Fig.4.

We use intrusion detection system to monitor network first. And then we define an obvious attack mode base on requirement. Intrusion detection system does extra process to obvious attack mode. In obvious attack mode, system set a time parameter T1 first. When this mode detects an obvious attack setting before, intrusion detection system monitors this attack continuously. Time between network attack occurs until PRS sends message to firewall sets to be T1 and than we set another parameter T (T is a threshold setting by user experience). If value of T1 bigger than T, PRS will send command lines to firewall, these command

lines can set by user in advance. Command lines in here will different base on firewall user used. Firewall can use these command lines from PRS to do some defend immediately.

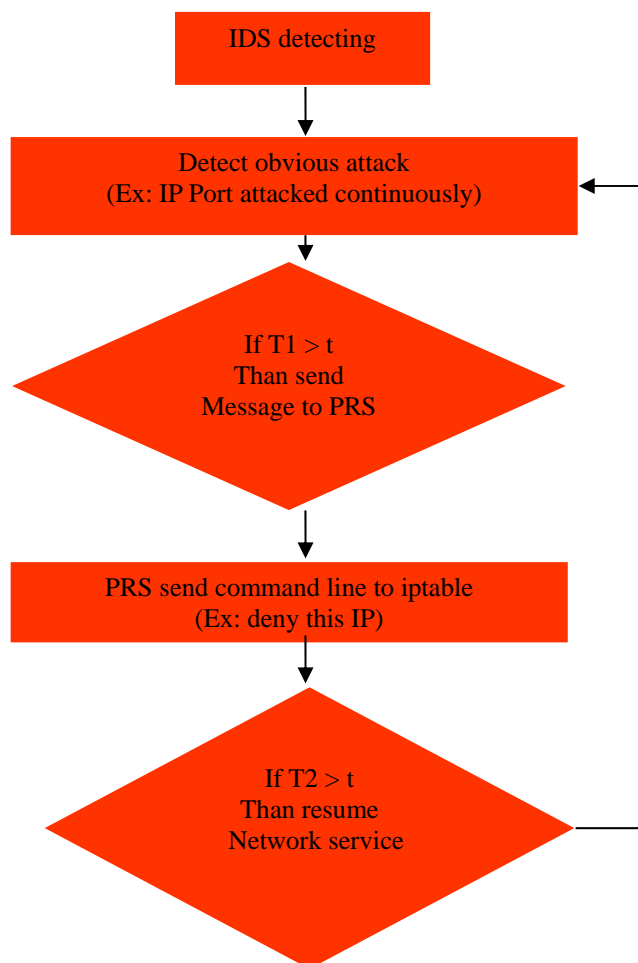


Fig.4 Flowchart of defend serious attack

For example, IP from 192.168.1.1 uses DOS to attack network. We set $T = 10$ minutes first. If DOS attacks network more than 10 minutes continuously, and a default command line for PRS is `iptables -A INPUT -s AttackIP -j DROP`. Therefore, when attack time bigger than 10 minutes, PRS will set command line to firewall (iptables is firewall used in our experiment). Firewall can deny this attack by command line sent by PRS. We will set one time parameter T_2 to resume network service. T_2 is a time across attack start to the end. When T_2 is bigger than 10 minutes, PRS will send iptables `-A INPUT -s 192.168.1.1 -j ACCEPT` to firewall. Firewall can resume service to IP from 192.168.1.1 at this moment.

IV. 1 Compare to Network Security System

In our research, why we use open source software to develop our system? There is a comparison of open source software and commercial software shows in table1. Information of this table is from report write by Dr. Ying-Dar Lin [8]. Open source software in this table is iptable. We can find open

source software is as well as commercial software in detection ability. But it has a great difference in price. It does not mean commercial software is expensive and weak. Because of commercial software has more other function of its system. In this table, we want to show open source software is cost down and still have a good detection in network security.

IV. 2 Display Report

In personal report system, we can analyze alert message sent from firewall and intrusion detection system. And the result shows in Fig.5. This figure shows frequency of alert message generating. And analysis information is collected by firewall and intrusion detection system. Such as source port, distant port, etc.

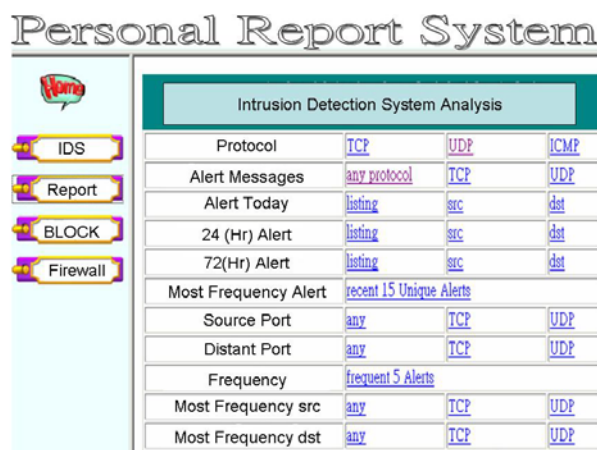


Fig.5: Analysis report

V. Conclusion

In this research, we present a multilevel network structure. This structure integrates intrusion detection system, firewall and personal report system to build more safety network.

All of our structure promotes to use open source software to build a system because of it can make cost down and make user or system manager more convenience and easy to maintain. Personal report system can generate different formats report by user setting. So user can generate report easy to understand and suit by himself. And it is special to generate different reports according to different positions in company.

PRS can use time parameter to send commend for firewall when network has an obvious attack. So that firewall can handle this attack immediately. In traditional situation, system manager gets alert messages and handles this attack wasting time. Our structure integrates network security concepts and reduces burden of system manager.

In our research, it cannot support all of intrusion detection system and firewall yet. We will keep on our research in maintain and development system. Structure

presents a basis structure, and it has more development in this structure. It can be build more function on this platform.

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Table1: Comparison of open source software and commercial software

Company/ Product	Packet Filter	DMZ	URL Filter		HTTP Content Filter		Price
			Exactly String Match	Regular Expression	Java	JavaScript	
Open Source Software	Yes	Yes	Yes	Yes	Yes	Yes	NT\$0
BorderWare Firewall Server	Yes	Yes	(need license)	N/A	No	No	NT\$550,000
CheckPoint VPN/Firewall-1	Yes	Yes	No	No	No	No	NT\$559,860
Cisco PIX 525R	Yes	Need card	External	N/A	Yes	Yes	NT\$880,000
NetScreen-100	Yes	Yes	External	N/A	Yes	Yes	NT\$665,000

Privacy-Preserving Decision Tree Classification Over Horizontally Partitioned Data

Justin Zhan¹, Stan Matwin², and LiWu Chang³

^{1,2}School of Information Technology & Engineering, University of Ottawa, Canada

³Center for High Assurance Computer Systems, Naval Research Laboratory, USA

{zhizhan, stan}@site.uottawa.ca, lchang@itd.nrl.navy.mil

Abstract: Protection of privacy is one of important problems in data mining. The unwillingness to share their data frequently results in failure of collaborative data mining. This paper studies how to build a decision tree classifier under the following scenario: a database is horizontally partitioned into multiple pieces, with each piece owned by a particular party. All the parties want to build a decision tree classifier based on such a database, but due to the privacy constraints, neither of them wants to disclose their private pieces. We build a privacy-preserving system, including a set of secure protocols, that allows the parties to construct such a classifier. We guarantee that the private data are securely protected.

Keywords: Privacy, decision tree, classification.

I. Introduction

Business success often relies on collaboration. The collaboration is even more critical in the modern business world, not only because of mutual benefit it brings but also because the coalition of multiple partners will be more competitive than each individual. Assuming they trust each other to a degree that they can share their private data, the collaboration becomes straightforward. However, in many scenarios, sharing data are impossible because of privacy concerns. Thus, collaboration without sharing private data becomes extremely important.

In this paper, we study a prevalent collaboration scenario, the collaboration involving a data mining task: multiple parties, each having a private data set, want to conduct data mining on the joint data set that is the union of all individual data sets; however, because of the privacy constraints, no party wants to disclose its private data set to each other. The objective of this paper is to develop efficient methods that enable this type of computation while minimizing the amount of the private information that each party has to disclose.

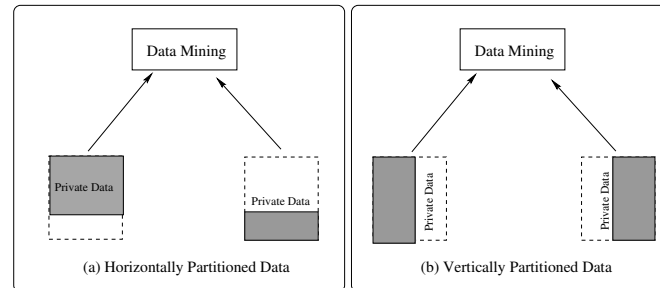


Figure 1:

Data mining includes various algorithms such as classification, association rule mining, and clustering. In this paper, we focus on classification. There are two types of classification between two collaborative parties: Figure 1(a) shows the data classification on the horizontally partitioned data, and Figure 1(b) shows the data classification on the vertically partitioned data. We study the classification on the horizontally partitioned data. In particular, we study how to build a decision tree classifier on private data. We have developed a privacy-preserving system that allows them to build a decision tree classifier based on their joint data.

II. Privacy-Preserving Decision-Tree Classification

Classification is an important problem in the field of data mining. In classification, we are given a set of example records, called the training data set, with each record consisting of several attributes. One of the categorical attributes, called the class label, indicates the class to which each record belongs. The objective of classification is to use the training data set to build a model of the class label such that it can be used to classify new data whose class labels are unknown.

Many types of models have been built for classification, such as neural networks, statistical models, genetic models, and decision tree models. The decision tree models are found to be the most useful in the domain of data

mining since they obtain reasonable accuracy and they are relatively inexpensive to compute. We define our problem as follows:

Problem 1 *We consider the scenario where n parties, each having a private data set (denoted by S_1, S_2, \dots, S_n respectively), want to collaboratively conduct decision tree classification on the union of their data sets. The data sets are assumed to be horizontally partitioned. Because they are concerned about the data privacy, neither party is willing to disclose its raw data set to others.*

Next, we give the notations that we will follow.

II.1 Notations

- e : public key.
- d : private key.
- P_i : the i th party.
- n : the total number of parties. Assuming $n > 2$.
- m : the total number of class.
- α is the number of bits for each transmitted element in the privacy-preserving protocols.
- N : the total number of records.

II.2 Decision Tree Classification Algorithm

Classification is one of the forms for data analysis that can be used to extract models describing important data classes or to predict future data. It has been studied extensively by the community in machine learning, expert system, and statistics as a possible solution to knowledge discovery problems. The decision tree is one of the classification methods. A decision tree is a class discriminator that recursively partitions the training set until each partition entirely or dominantly consists of examples from one class. A well known algorithm for building decision tree classifiers is ID3 [13]. We describe the algorithm below where S represents the training samples and AL represents the attribute list:

ID3(S, AL)

1. Create a node V .
2. **If** S consists of samples with all the same class **C** **then** return V as a leaf node labelled with class C .
3. **If** AL is empty, **then** return V as a leaf-node with the majority class in S .
4. Select test attribute (TA) among the AL with the highest information gain.
5. Label node V with TA .

6. **For** each known value a_i of TA

- (a) Grow a branch from node V for the condition $TA = a_i$.
- (b) Let s_i be the set of samples in S for which $TA = a_i$.
- (c) **If** s_i is empty **then** attach a leaf labelled with the majority class in S .
- (d) **Else** attach the node returned by **ID3**($s_i, AL - TA$).

According to ID3 algorithm, each non-leaf node of the tree contains a splitting point, and the main task for building a decision tree is to identify an attribute for the splitting point based on the information gain. Information gain can be computed using *entropy*. In the following, we assume there are m classes in the whole training data set. *Entropy*(S) is defined as follows:

$$Entropy(S) = - \sum_{j=1}^m Q_j \log Q_j, \quad (1)$$

where Q_j is the relative frequency of class j in S . Based on the entropy, we can compute the information gain for any candidate attribute A if it is used to partition S :

$$Gain(S, A) = Entropy(S) - \sum_{v \in A} \left(\frac{|S_v|}{|S|} Entropy(S_v) \right), \quad (2)$$

where v represents any possible values of attribute A ; S_v is the subset of S for which attribute A has value v ; $|S_v|$ is the number of elements in S_v ; $|S|$ is the number of elements in S . To find the best split for a tree node, we compute information gain for each attribute. We then use the attribute with the largest information gain to split the node.

II.3 Cryptography Tools

In this paper, we use the concept of homomorphic encryption which was originally proposed in [18]. Since then, many such systems have been proposed [3, 15, 16, 17]. We observe that some homomorphic encryption schemes, such as [4], are not robust against chosen cleartext attacks. However, we base our secure protocols on [17], which is semantically secure [9].

In our secure protocols, we use additive homomorphism offered by [17]. In particular, we utilize the following characterizer of the homomorphic encryption functions: $e(a_1) \times e(a_2) = e(a_1 + a_2)$ where e is an encryption function; a_1 and a_2 are the data to be encrypted. Because of the property of associativity, $e(a_1 + a_2 + \dots + a_n)$ can be computed as $e(a_1) \times e(a_2) \times \dots \times e(a_n)$ where $e(a_i) \neq 0$. That is

$$d(e(a_1 + a_2 + \dots + a_n)) = d(e(a_1) \times e(a_2) \times \dots \times e(a_n)) \quad (3)$$

$$d(e(\alpha_1)^{\alpha_2}) = d(e(\alpha_1 \alpha_2)) \quad (4)$$

II.4 Privacy-Preserving Decision Tree Classification System

The privacy-preserving classification system contains several secure protocols that multiple parties need follow. There are five major steps:

- To compute $Entropy(S_v)$.
- To compute $\frac{|S_v|}{|S|}$.
- To compute $\frac{|S_v|}{|S|} Entropy(S_v)$.
- To compute information gain for each candidate attribute.
- To compute the attribute with the largest information gain.

The goal of our privacy-preserving classification system is to disclose no private data in every step. We firstly select a key generator who produces the encryption and decryption key pairs. The computation of the whole system is under encryption. For the purpose of illustration, let's assume that P_n is the key generator who generates a homomorphic encryption key pair (e, d) . Next, we will show how to conduct each step.

II.4.1 Computation of $e(Entropy(S_v))$

Protocol 1 To compute $e(Q_j)$

1. Each party computes their own share of $|S_v|$. Assuming P_1 gets c_1 , P_2 gets c_2 , \dots , P_n gets c_n .
2. P_n sends $e(c_n)$ to P_1 .
3. P_1 computes $e(c_n) \times e(c_1) = e(c_1 + c_n)$ and sends it to P_2 .
4. Repeat until P_{n-1} obtains $e(c_1 + c_2 + \dots + c_n)$.
5. P_{n-1} computes $e(\sum_{i=1}^n c_i)^{\frac{1}{n}} = e(Q_j)$.

Protocol 2 To compute $e(Q_j \log(Q_j))$

1. P_{n-1} generates a set of random numbers r_1, r_2, \dots , and r_t .
2. P_{n-1} sends the sequence of $e(Q_j)$, $e(r_1)$, $e(r_2)$, \dots , $e(r_t)$ to P_n in a random order.
3. P_n decrypts each element in the sequence, and sends $\log(Q_j)$, $\log(r_1)$, $\log(r_2)$, \dots , $\log(r_t)$ to P_1 in the same order as P_{n-1} did.
4. P_1 adds a random number R to each of the elements, then sends them to P_{n-1} .
5. P_{n-1} obtains $\log(Q_j) + R$ and computes $e(Q_j)^{(\log(Q_j)+R)} = e(Q_j \log(Q_j) + RQ_j)$.

6. P_{n-1} sends $e(Q_j)$ to P_1 .

7. P_1 computes $e(Q_j)^{-R} = e(-RQ_j)$ and sends it to P_{n-1} .

8. P_{n-1} computes $e(Q_j \log(Q_j) + RQ_j) \times e(-RQ_j) = e(Q_j \log(Q_j))$.

Protocol 3 To compute $e(Entropy(S_v))$

1. Repeat protocol 1-2 to compute $e(Q_j \log(Q_j))$ for all j 's.
2. P_{n-1} computes $e(Entropy(S_v)) = \prod_j e(Q_j \log(Q_j)) = e(\sum_j Q_j \log(Q_j))$.

Theorem 1 (Correctness). Protocol 1-3 correctly compute $Entropy$.

Proof In protocol 1, P_{n-1} obtains $e(Q_j)$. In protocol 2, P_{n-1} gets $e(Q_j \log(Q_j))$. These two protocols are repeatedly used until P_{n-1} obtains $e(Q_j \log(Q_j))$ for all j 's. In protocol 3, P_{n-1} computes the entropy by all the terms previously obtained. Notice that although we use $Entropy(S_v)$ to illustrate, $Entropy(S)$ can be computed following the above protocols with different input attributes. ■

Theorem 2 (Privacy-Preserving). Assuming the parties follow the protocol, the private data are securely protected.

Proof In protocol 1, all the data transmission are hidden under encryption. The parties who are not the key generator can't see other parties' private data. On the other hand, the key generator doesn't obtain the encryption of other parties's private data. Therefore, protocol 1 discloses no private data. In protocol 2, although P_{n-1} sends $e(Q_j)$ to P_n , Q_j is hidden by a set of random numbers known only by P_{n-1} . Thus private data are not revealed. In protocol 3, the computations are still under encryption, no private data are disclosed either. ■

Theorem 3 (Efficiency). The computation of $Entropy$ is efficient from both computation and communication point of view.

Proof To prove the efficiency, we need conduct complexity analysis of the protocol. The bit-wise communication cost of protocol 1 is $\alpha(n-1)$, of protocol 2 is $\alpha(3t+5)$. The total communication cost has the upper bound of $\alpha m(n+3t+4)$. The computation cost of protocol 1 is nN , of protocol 2 is $5t+3$. The total computation cost is upper bounded by $mnN + 5mt + 4m$. Therefore, the protocols are sufficient fast. ■

II.4.2 The Computation of $\frac{|S_v|}{|S|} \text{Entropy}(S_v)$

Protocol 4 To Compute $\frac{|S_v|}{|S|}$

1. P_{n-1} sends $e(|S_v|)$ to P_1 .
2. P_{n-1} generates a set of random numbers: r_1, r_2, \dots, r_t .
3. P_{n-1} sends $e(|S|), e(r_1), \dots$, and $e(r_t)$ to P_n in a random order. Note that $e(|S|)$ can be computed following the first four steps of protocol 1.
4. P_n decrypts each element, then sends the sequence of $\frac{1}{|S|}, \frac{1}{r_1}, \dots$, and $\frac{1}{r_t}$ to P_1 in the same order as P_{n-1} did.
5. P_1 computes $e(|S_v|)^\varpi$ where ϖ denotes for each decrypted element, then sends the sequence to P_{n-1} in the same order as P_n did.
6. P_{n-1} obtains $e(\frac{|S_v|}{|S|})$ since he knows the original permutations.

Up to now, P_{n-1} has obtained $e(\frac{|S_v|}{|S|})$ and $e(\text{Entropy}(S_v))$. Next, we discuss how to compute $\frac{|S_v|}{|S|} \text{Entropy}(S_v)$.

Protocol 5 To Compute $\frac{|S_v|}{|S|} \text{Entropy}(S_v)$

1. P_{n-1} sends $e(\frac{|S_v|}{|S|})$ to P_1 .
2. P_1 computes $e(\frac{|S_v|}{|S|}) \times e(R') = e(\frac{|S_v|}{|S|} + R')$ where R' is a random number only known by P_1 , then sends $e(\frac{|S_v|}{|S|} + R')$ to P_n .
3. P_n decrypts it and sends $\frac{|S_v|}{|S|} + R'$ to P_{n-1} .
4. P_{n-1} computes $e(\text{Entropy}(S_v))^{(\frac{|S_v|}{|S|} + R')}$ = $e(\frac{|S_v|}{|S|} \text{Entropy}(S_v) + R' \text{Entropy}(S_v))$.
5. P_{n-1} sends $e(\text{Entropy}(S_v))$ to P_1 .
6. P_1 computes $e(\text{Entropy}(S_v))^{-R'}$ = $e(-R' \text{Entropy}(S_v))$, and sends it to P_{n-1} .
7. P_{n-1} computes $e(\frac{|S_v|}{|S|} \text{Entropy}(S_v)) + R' \text{Entropy}(S_v) \times e(-R' \text{Entropy}(S_v))$ = $e(\frac{|S_v|}{|S|} \text{Entropy}(S_v))$.

Theorem 4 (Correctness). Protocol 4-5 correctly computes $\frac{|S_v|}{|S|} \text{Entropy}(S_v)$.

Proof In protocol 4, P_{n-1} obtains $e(\frac{|S_v|}{|S|})$. In protocol 5, P_{n-1} gets $\frac{|S_v|}{|S|} \text{Entropy}(S_v)$. The computation uses the both properties of homomorphic encryption. ■

Theorem 5 (Privacy-Preserving). Assuming the parties follow the protocol, the private data are securely protected.

Proof In protocol 4, P_n sends $e(|S|)$ to P_{n-1} but it is hidden by a set of random numbers known only by P_{n-1} . Although P_1 receives a decrypted sequence, $\frac{1}{|S|}$ is also hidden by a set of random numbers. Thus, P_1 and P_n are prevented from knowing $|S|$. On the other hand, P_{n-1} is also hidden from knowing $|S|$ since all the terms he holds are under encryption. In protocol 5, although P_1 sends $e(\frac{|S_v|}{|S|} + R')$ to P_n , $\frac{|S_v|}{|S|}$ is hidden by a random number known only by P_1 . Therefore, private data are not revealed. ■

Theorem 6 (Efficiency). The computation of protocol 4 and protocol 5 is efficient from both computation and communication point of view.

Proof To prove the efficiency, we need conduct complexity analysis of the protocol. The total communication cost is $\alpha(3t + 4)$. The total computation cost is upper bounded by $6t$. Therefore, the protocols are very efficient. ■

II.4.3 The Computation of the Attribute With the Largest Information Gain

Following the above protocols, we can compute $e(\text{Entropy}(S)), \frac{|S_v|}{|S|} \text{Entropy}(S_v)$. What left is to compute information gain for each attribute and select the attribute with the largest information gain.

Protocol 6 To Compute Information Gain for An Attribute

1. P_{n-1} computes $\prod_{v \in A} e(\frac{|S_v|}{|S|} \text{Entropy}(S_v))$ = $\sum_{v \in A} \frac{|S_v|}{|S|} \text{Entropy}(S_v)$.
2. He computes $e(\sum_{v \in A} \frac{|S_v|}{|S|} \text{Entropy}(S_v))^{-1}$ = $e(-\sum_{v \in A} \frac{|S_v|}{|S|} \text{Entropy}(S_v))$.
3. He computes $e(\text{Gain}(S, A))$ = $e(\text{Entropy}(S)) \times e(-\sum_{v \in A} \frac{|S_v|}{|S|} \text{Entropy}(S_v))$.

Once we compute the information gain for each candidate attribute, we then compute the attribute with the largest information gain. Without loss of generality, assuming there are k information gains: $e(g_1), e(g_2), \dots$, and $e(g_k)$, with each corresponding to a particular attribute.

Protocol 7 To Compute the Largest Information Gain

	g_1	g_2	g_3	\dots	g_k
g_1	+1	+1	-1	\dots	-1
g_2	-1	+1	-1	\dots	-1
g_3	+1	+1	+1	\dots	+1
\dots	\dots	\dots	\dots	\dots	\dots
g_k	+1	+1	-1	\dots	+1

Table 1:

	S_1	S_2	S_3	S_4	Weight
S_1	+1	-1	-1	-1	-2
S_2	+1	+1	-1	+1	+2
S_3	+1	+1	+1	+1	+4
S_4	+1	-1	-1	+1	0

Table 2:

1. P_{n-1} computes $e(g_i) \times e(g_j)^{-1} = e(g_i - g_j)$ for all $i, j \in [1, k], i > j$, and sends the sequence denoted by φ to P_n in a random order.
2. P_n decrypts each element in the sequence φ . He assigns the element +1 if the result of decryption is not less than 0, and -1, otherwise. Finally, he obtains a +1/-1 sequence denoted by φ' .
3. P_n sends +1/-1 sequence φ' to P_{n-1} who computes the largest element.

Theorem 7 (Correctness). *Protocol 6-7 correctly computes the attribute with the largest information gain.*

Proof In protocol 6, P_{n-1} obtains $e(\text{Gain}(S, A))$. In protocol 7, P_{n-1} gets the attribute with the largest information. We discuss the details as follows:

P_{n-1} is able to remove permutation effects from φ' (the resultant sequence is denoted by φ'') since she has the permutation function that she used to permute φ , so that the elements in φ and φ'' have the same order. It means that if the q th position in sequence φ denotes $e(g_i - g_j)$, then the q th position in sequence φ'' denotes the evaluation results of $g_i - g_j$. We encode it as +1 if $g_i \geq g_j$, and as -1 otherwise. P_{n-1} has two sequences: one is the φ , the sequence of $e(g_i - g_j)$, for $i, j \in [1, k] (i > j)$, and the other is φ'' , the sequence of +1/-1. The two sequences have the same number of elements. P_{n-1} knows whether or not g_i is larger than g_j by checking the corresponding value in the φ'' sequence. For example, if the first element φ'' is -1, P_{n-1} concludes $g_i < g_j$. P_{n-1} examines the two sequences and constructs the index table (Table 1) to compute the largest element.

In Table 1, +1 in entry ij indicates that the information gain of the row (e.g., g_i of the i th row) is not less than the information gain of a column (e.g., g_j of the j th column); -1, otherwise. P_{n-1} sums the index values

of each row and uses this number as the weight of the information gain in that row. She then selects the one that corresponds to the largest weight.

To make it clearer, let's illustrate it by an example. Assume that: (1) there are 4 information gains with $g_1 < g_4 < g_2 < g_3$; (2) the sequence φ is $[e(g_1 - g_2), e(g_1 - g_3), e(g_1 - g_4), e(g_2 - g_3), e(g_2 - g_4), e(g_3 - g_4)]$. The sequence φ'' will be $[-1, -1, -1, -1, +1, +1]$. According to φ and φ'' , P_{n-1} builds the Table 2. From the table, P_{n-1} knows g_3 is the largest element since its weight, which is +4, is the largest. ■

Theorem 8 (Privacy-Preserving). *Assuming the parties follow the protocol, the private data are securely protected.*

Proof In protocol 6, there is no data transmission. In protocol 7, we need prove it from two aspects: (1) P_{n-1} doesn't get information gain (e.g., g_i) for each attribute. What P_{n-1} gets are $e(g_i - g_j)$ for all $i, j \in [1, k], i > j$ and +1/-1 sequence. By $e(g_i - g_j)$, P_{n-1} cannot know each information gain since it is encrypted. By +1/-1 sequence, P_{n-1} can only know whether or not g_i is greater than P_j . (2) P_n doesn't obtain information gain for each attribute either. Since the sequence of $e(g_i - g_j)$ is randomized before being send to P_n who can only know the sequence of $g_i - g_j$, he can't get each individual information gain. Thus private data are not revealed. ■

Theorem 9 (Efficiency). *The computation of protocol 6 and protocol 7 is efficient from both computation and communication point of view.*

Proof The total communication cost is upper bounded by αm^2 . The total computation cost is upper bounded by $m^2 + m + 1$. Therefore, the protocols are very fast. ■

III. Overall Discussion

Our privacy-preserving classification system contains several components. In Section , we show how to correctly compute $e(\text{Entropy}(S_v))$. In Section , we present protocols to compute $\frac{|S_v|}{|S|} \text{Entropy}(S_v)$. In Section , we show how to compute information gain for each candidate attribute; we then describe how to obtain the attribute with the largest information gain. We discussed the correctness of the computation in each section. Overall correctness is also guaranteed.

As for the privacy protection, all the communications between the parties are encrypted, therefore, the parties who has no decryption key cannot gain anything out of the communication. On the other hand, there are some communication between the key generator and

other parties. Although the communications are still encrypted, the key generator may gain some useful information. However, we guarantee that the key generator cannot gain the private data by adding random numbers in the original encrypted data so that even if the key generator get the intermediate results, there is little possibility that he can know the intermediate results. Therefore, the private data are securely protected with overwhelming probability.

IV. Conclusion

Prior to conclude this paper. We describe the most related works. In early work on privacy-preserving data mining, Lindell and Pinkas [14] propose a solution to privacy-preserving classification problem using oblivious transfer protocol, a powerful tool developed by secure multi-party computation (SMC) research [22, 10]. The techniques based on SMC for efficiently dealing with large data sets have been addressed in [21]. Randomization approaches were firstly proposed by Agrawal and Srikant in [2] to solve privacy-preserving data mining problem. Researchers proposed more random perturbation-based techniques to tackle the problems (e.g., [5, 19, 7]). In addition to perturbation, aggregation of data values [20] provides another alternative to mask the actual data values. In [1], authors studied the problem of computing the k th-ranked element. Dwork and Nissim [6] showed how to learn certain types of boolean functions from statistical databases in terms of a measure of probability difference with respect to probabilistic implication, where data are perturbed with noise for the release of statistics.

The problem we are studying is actually a special case of a more general problem, the Secure Multi-party Computation (SMC) problem. Briefly, a SMC problem deals with computing any function on any input, in a distributed network where each participant holds one of the inputs, while ensuring that no more information is revealed to a participant in the computation than can be inferred from that participant's input and output [12]. The SMC problem literature is extensive, having been introduced by Yao [22] and expanded by Goldreich, Micali, and Wigderson [11] and others [8]. It has been proved that for any function, there is a secure multi-party computation solution [10]. The approach used is as follows: the function F to be computed is first represented as a combinatorial circuit, and then the parties run a short protocol for every gate in the circuit. Every participant gets corresponding shares of the input wires and the output wires for every gate. This approach, though appealing in its generality and simplicity, means that the size of the protocol depends on the size of the circuit, which depends on the size of the input. This is highly ineffi-

cient for large inputs, as in data mining. It has been well accepted that for special cases of computations, special solutions should be developed for efficiency reasons.

In this paper, we provide a novel solution for decision tree classification over horizontally partitioned private data. Instead of using data transformation, we define a protocol using homomorphic encryption to exchange the data while keeping it private. Our classification system is quite efficient that can be envisioned by the communication and computation complexity. The total communication complexity is upper bounded by $\alpha(m^2 + nm + 3tm + 4m + 3t + 4)$. The computation complexity is upper bounded by $mnN + m^2 + 5mt + 5m + 6t + 1$.

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Privacy-Preserving Support Vector Machines Learning

Justin Zhan⁺, LiWu Chang^{*} and Stan Matwin⁺

⁺School of Information Technology & Engineering, University of Ottawa, Canada

^{*}Center for High Assurance Computer Systems, Naval Research Laboratory, USA

zhizhan@site.uottawa.ca, lchang@itd.nrl.navy.mil, stan@site.uottawa.ca

Abstract: This paper addresses the problem of data sharing among multiple parties, without disclosing the data between the parties. We focus on sharing of data among parties involved in a data mining task. We study how to share private or confidential data in the following scenario: without disclosing their private data to each other, multiple parties, each having a private data set, want to collaboratively construct support vector machines using a linear, polynomial or sigmoid kernel function. To tackle this problem, we develop a secure protocol for multiple parties to conduct the desired computation. The solution is distributed, i.e., there is no central, trusted party having access to all the data. Instead, we define a protocol using homomorphic encryption techniques to exchange the data while keeping it private. We analyze the protocol in the context of mistakes and malicious attacks, and show its robustness against such attacks. All the parties are treated symmetrically: they all participate in the encryption and in the computation involved in learning support vector machines.

Keywords: Privacy, security, support vector machine, secure multi-party computation.

I. Introduction

In this paper, we address the following problem: multiple parties are cooperating on a data-rich task. Each of the parties owns data pertinent to the aspect of the task addressed by this party. More specifically, the data consists of instances, each party owns her instances but all parties have the same attributes. The overall performance, or even solvability, of this task depends on the ability of performing data mining using all the instances of all the parties. The parties, however, may be unwilling to release their instances to other parties, due to privacy or confidentiality of the data. How can we structure information sharing between the parties so that the data will be shared for the purpose of data mining, while at the same time specific instance values will be kept con-

fidential by the parties to whom they belong? This is the task addressed in this paper. In the privacy-oriented data mining this task is known as data mining with horizontally partitioned data (also known as homogeneous collaboration [15].) Examples of such tasks abound in business, homeland security, coalition building, medical research, etc.

The following scenarios illustrate situations in which this type of collaboration is interesting: (i) Multiple competing supermarkets, each having an extra large set of data records of its customers' buying behaviors, want to conduct data mining on their joint data set for mutual benefit. Since these companies are competitors in the market, they do not want to disclose their customers' information to each other, but they know the results obtained from this collaboration could bring them an advantage over other competitors. (ii) Success of homeland security aiming to counter terrorism depends on combination of strength across different mission areas, effective international collaboration and information sharing to support coalition in which different organizations and nations must share some, but not all, information. Information privacy thus becomes extremely important: all the parties of the collaboration promise to provide their private data to the collaboration, but neither of them wants each other or any other party to learn much about their private data.

Without privacy concerns, all parties can send their data to a trusted central place to conduct the mining. However, in situations with privacy concerns, the parties may not trust anyone. We call this type of problem the *Privacy-preserving Collaborative Data Mining problem*. As stated above, in this paper we are interested in homogeneous collaboration where each party has the same sets of attributes [15] but has different sets of instances.

Data mining includes a number of different tasks, such as association rule mining, classification, and clustering, etc. This paper studies how to learn support vector machines. In the last few years, there has been a surge of interest in Support Vector Machines (SVM) [29, 28]. SVM is a powerful methodology for solving problems in nonlinear classification, function estimation and density estimation which has also led to many other recent developments in kernel based learning methods in gen-

eral [7, 25, 24]. SVMs have been introduced within the context of statistical learning theory and structural risk minimization. As part of the SVM algorithm, one solves convex optimization problems, typically quadratic programs. It has been empirically shown that SVMs have good generalization performance on many applications such as text categorization [13], face detection [20], and handwritten character recognition [16]. Based on the existing SVM learning technologies, we study the problem of learning Support Vector Machines on private data. More precisely, the problem is defined as follows: multiple parties want to build support vector machines on a data set that consists of private data of all the parties, but none of the parties is willing to disclose her raw data to each other or any other parties. We develop a secure protocol, based on homomorphic cryptography and random perturbation techniques, to tackle the problem. An important feature of our approach is its distributed character, i.e. there is no single, centralized authority that all parties need to trust. Instead, the computation is distributed among parties, and its structure and the use of homomorphic encryption ensures privacy of the data.

The paper is organized as follows: The related work is discussed in Section 2. We describe the SVMs training procedure in Section 3. We then present our proposed secure protocols in Section 4. We give our conclusion in Section 5.

II. Related Work

II.1 Secure Multi-Party Computation

A Secure Multi-party Computation (SMC) problem deals with computing any function on any input, in a distributed network where each participant holds one of the inputs, while ensuring that no more information is revealed to a participant in the computation than can be inferred from that participant's input and output. The SMC problem literature was introduced by Yao [31]. It has been proved that for any polynomial function, there is a secure multi-party computation solution [12]. The approach used is as follows: the function F to be computed is firstly represented as a combinatorial circuit, and then the parties run a short protocol for every gate in the circuit. Every participant gets corresponding shares of the input wires and the output wires for every gate. This approach, though appealing in its generality and simplicity, is highly impractical for large datasets.

II.2 Privacy-Preserving Data Mining

In early work on privacy-preserving data mining, Lindell and Pinkas [17] propose a solution to privacy-preserving classification problem using oblivious transfer protocol,

a powerful tool developed by secure multi-party computation (SMC) research. The techniques based on SMC for efficiently dealing with large data sets have been addressed in [14], where a solution to the association rule mining problem for the case of two parties was proposed.

Randomization approaches were firstly proposed by Agrawal and Srikant in [3] to solve privacy-preserving data mining problem. In addition to perturbation, aggregation of data values [26] provides another alternative to mask the actual data values. In [1], authors studied the problem of computing the k th-ranked element. Dwork and Nissim [9] showed how to learn certain types of boolean functions from statistical databases in terms of a measure of probability difference with respect to probabilistic implication, where data are perturbed with noise for the release of statistics. In this paper, we focus on privacy-preserving among the inter-party computation.

Homomorphic encryption [21], which transforms multiplication of encrypted plaintexts into the encryption of the sum of the plaintexts, has recently been used in secure multi-party computation. For instance, Freedmen, Nissim and Pinkas [10] applied it for set intersection. For computing set intersection, unlike [10], [2] and [27] proposed an approach based on commutative encryption. The work most related to ours is [30], where Wright and Yang applied homomorphic encryption [21] to the Bayesian networks induction for the case of *two* parties. The work that are closely related ours is [32], where Zhan et.al. present secure protocols for learning support vector machine over vertically partitioned data. In this paper, we develop a secure protocol, based on homomorphic encryption and random perturbation techniques, for multiple parties to build SVMs over horizontally partitioned data without compromising their data privacy.

III. Learning SVMs On Private Data

Support vector machines were invented by Vapnik [29] in 1982. The idea consists of mapping the space of input examples into a high-dimensional feature space, so that the optimal separating hyperplane built on this space allow a good generalization capacity. The input examples become linearly or almost linearly separable in the high dimensional space through selecting an adequate mapping [28]. Research on SVMs is extensive since it was invented. However, to our best knowledge, there is no effort on learning SVMs on private data. In this paper, our goal is to provide a privacy-preserving algorithm for multi-parties to collaboratively learn SVMs without compromising their data privacy.

III.1 Problem

We consider the scenario where multiple parties P_1, P_2, \dots , and P_n , each having a private data set (denoted by D_1, D_2, \dots and D_n respectively), want to collaboratively learn SVMs on the concatenation of their data sets. Because they are concerned about their data privacy, neither party is willing to disclose its actual data set to others. Specially, we consider the homogeneous collaboration where each data set contains the same number of attributes but different set of instances. Let m be the total number of attributes in each data set. Let N be the total number of instances, N_1 is the number of instances for P_1 , N_2 is the number of instances for P_2, \dots , and N_n is the number of instances for P_n . We further assume that the class labels are shared but the instance identifiers and actual attribute values are kept confidential.

III.2 Overview of Support Vector Machine

SVM is primarily a two-class classifier for which the optimization criterion is the width of the margin between the different classes. In the linear form, the formula for output of a SVM is

$$u = \vec{w} \cdot \vec{x} + b, \quad (1)$$

where \vec{w} is the normal vector to the hyperplane and \vec{x} is the input vector. To maximize margin, we need minimize the following [5]:

$$\min_{\vec{w}, b} \frac{1}{2} \|\vec{w}\|^2, \quad (2)$$

subject to $y_i(\vec{w} \cdot \vec{x}_i + b) \geq 1, \forall i$, where \vec{x}_i is the i th training example, and y_i is the correct output of the SVM for the i th training example. The value y_i is +1 (resp. -1) for the positive (resp. negative) examples in a class.

Through introducing Lagrangian multipliers, the above optimization can be converted into a dual quadratic optimization problem.

$$\min_{\vec{\alpha}} \Psi(\vec{\alpha}) = \min_{\alpha_i, \alpha_j} \frac{1}{2} \sum_{i,j=1}^N \alpha_i \alpha_j y_i y_j K(\vec{x}_i, \vec{x}_j) - \sum_{i=1}^N \alpha_i, \quad (3)$$

where α_i are the Lagrange multipliers, $\vec{\alpha} = \alpha_1, \alpha_2, \dots, \alpha_N$, subject to inequality constraints: $\alpha_i \geq 0, \forall i$, and linear equality constraint: $\sum_{i=1}^N y_i \alpha_i = 0$.

By solving the dual optimization problem, one obtains the coefficients $\alpha_i, i = 1, \dots, N$, from which the normal vector \vec{w} and the threshold b can be derived [22].

To deal with non-linearly separable data in feature space, Cortes and Vapnik [6] introduced slack-variables

to relax the hard-margin constraints. The modification is:

$$\min \frac{1}{2} \|\vec{w}\|^2 + C \sum_{i=1}^N \xi_i \quad (4)$$

subject to $y_i(\vec{w} \cdot \vec{x}_i + b) \geq 1 - \xi_i, \forall i$, where ξ_i is slack variable that allows margin failure and constant $C > 0$ determines the trade-off between the empirical error and the complexity term. This leads to dual quadratic problem involving Eq.[3] subject to the constraints $C \geq \alpha_i \geq 0, \forall i$ and $\sum_{i=1}^N y_i \alpha_i = 0$.

To solve the dual quadratic problem, we apply sequential minimal optimization [22] which is a very efficient algorithm for training SVMs.

III.3 Sequential Minimal Optimization

Sequential Minimal Optimization (SMO) [22] is a simple algorithm that can efficiently solve the SVM quadratic optimization (QO) problem. Instead of directly tackle the QO problem, it decomposes the overall QO problem into QO sub-problems based on Osunna's convergence theorem [20]. At each step, SMO chooses two Lagrange multipliers to jointly optimize, find the optimal values for these multipliers, and updates the SVM to reflect the new optimal values.

In order to solve for the two Lagrange multipliers, SMO firstly computes the constraints on these multipliers and then solves for the constrained minimum. Normally, the objective function is positive definite, SMO computes the minimum along the direction of the linear constraints $\sum_{i=1}^2 y_i \alpha_i = 0$ within the boundary $C \geq \alpha_i \geq 0, i = 1, 2$.

$$\alpha_2^{\text{new}} = \alpha_2 + y_2(E_1 - E_2) \eta, \quad (5)$$

where $E_i = y_i \alpha_i K(\vec{x}_i, \vec{x}) - y_i$ is the error on the i th training example, \vec{x}_i is the stored training vector and \vec{x} is the input vector, and η is the second derivative of Eq.[3] along the direction of the above linear constraints:

$$\eta = K(\vec{x}_1, \vec{x}_1) + K(\vec{x}_2, \vec{x}_2) - 2K(\vec{x}_1, \vec{x}_2). \quad (6)$$

Next step, the constrained minimum is found by clipping the unconstrained minimum to the ends of the line segment: $\alpha_2^{\text{new,clipped}}$ is equal to H if $\alpha_2^{\text{new}} \geq H$, is equal to α_2^{new} if $L < \alpha_2^{\text{new}} < H$, and is equal to $\alpha_2^{\text{new,clipped}} = L$ if $\alpha_2^{\text{new}} \leq L$. If the target y_1 is not equal to the target y_2 , $L = \max(0, \alpha_2 - \alpha_1)$, $H = \min(C, C + \alpha_2 - \alpha_1)$. If the target y_1 is equal to the target y_2 , $L = \max(0, \alpha_2 + \alpha_1 - C)$, $H = \min(C, \alpha_2 + \alpha_1)$.

The value of α_1 is computed from the new, clipped, α_2 :

$$\alpha_1^{\text{new}} = \alpha_1 + s(\alpha_2 - \alpha_2^{\text{new,clipped}}), \quad (7)$$

where $s = y_1 y_2$.

In the procedure of sequential minimal optimization, the only step accessing the actual attribute values is the computation of the kernel function K . Kernel functions have various forms. Three types of kernel functions are considered: they are the linear kernel function $K = (\vec{a} \cdot \vec{b})$, the polynomial kernel function $K = ((\vec{a} \cdot \vec{b}) + \theta)^d$, where $d \in \mathbb{N}$, $\theta \in \mathcal{R}$ are constants, and the sigmoid kernel function $K = \tanh((\kappa(\vec{a} \cdot \vec{b}) + \theta))$, where $\kappa, \theta \in \mathcal{R}$ are constants, for instances \vec{a} and \vec{b} .

To compute these types of kernel functions, one needs to compute the inner product between two instances. If the two instances belong to the same party, this party can compute the inner product by herself; if one instance (e.g., \vec{x}_1) belongs to one party (e.g., P_1), and the other instance (e.g., \vec{x}_2) belongs to another party (e.g., P_2), then P_1 can compute $(\vec{x}_1 \cdot \vec{x}_1)$ and P_2 can compute $(\vec{x}_2 \cdot \vec{x}_2)$. However, to compute $(\vec{x}_1 \cdot \vec{x}_2)$, different parties have to collaborate. How to conduct this inner product computation across parties without compromising each party's data privacy presents a great challenge. In next section, secure protocols are developed to tackle this challenge.

IV. Protocols

IV.1 Introducing Homomorphic Encryption

The concept of homomorphic encryption was originally proposed in [23]. Since then, many such systems have been proposed [4, 18, 19, 21]. We observe that some homomorphic encryption schemes, such as [8], are not robust against chosen plaintext attacks. However, we base our secure protocols on [21], which is semantically secure [11].

In our secure protocols, we use additive homomorphism offered by [21]. In particular, we utilize the following characterizer of the homomorphic encryption functions: $e(a_1) \times e(a_2) = e(a_1 + a_2)$ where e is an encryption function; a_1 and a_2 are the data to be encrypted. Because of the property of associativity, $e(a_1 + a_2 + \dots + a_n)$ can be computed as $e(a_1) \times e(a_2) \times \dots \times e(a_n)$ where $e(a_i) \neq 0$. That is

$$d(e(a_1 + a_2 + \dots + a_n)) = d(e(a_1) \times e(a_2) \times \dots \times e(a_n)) \quad (8)$$

$$d(e(a_1)^{a_2}) = d(e(a_1 a_2)) \quad (9)$$

IV.2 A Secure Protocol

Let's assume that P_1 has an instance vector \vec{x}_1 and P_2 has an instance vector \vec{x}_2 . Both vectors have m elements. We use x_{1i} to denote the i th element in vector \vec{x}_1 , and x_{2i} to denote the i th element in vector \vec{x}_2 . In order to

compute the $K(\vec{x}_1, \vec{x}_2)$, the key issue is how P_1 and P_2 compute the inner product between \vec{x}_1 and \vec{x}_2 without disclosing them to each other. In our secure protocol, P_1 adds a random number to each of her actual data values, encrypts the masked values, and sends the encrypted masked terms to P_2 . By adding the random numbers, P_2 is prevented from guessing P_1 's actual values based on encryption patterns. Firstly, one of parties is randomly chosen as a key generator. For simplicity, let's assume P_1 is selected as the key generator. P_1 generates a cryptographic key pair (d, e) of a semantically-secure homomorphic encryption scheme and publishes its public key e . P_1 applies the encryption key to each element of x_1 (e.g., $e(x_{1i} + r_i)$). P_2 computes $e(\vec{x}_1 \cdot \vec{x}_2)$. He then sends $e(\vec{x}_1 \cdot \vec{x}_2)$ to P_1 who decrypts it and gets $(\vec{x}_1 \cdot \vec{x}_2)$.

We describe this more formally as

Protocol 1 *INPUT: P_1 's input is a vector $\vec{x}_1 = \{x_{11}, x_{12}, \dots, x_{1m}\}$, and P_2 's input is a vector $\vec{x}_2 = \{x_{21}, x_{22}, \dots, x_{2m}\}$. The elements in the input vectors are taken from the real number domain.*

1. P_1 performs the following operations:

- (a) She computes $e(x_{1i} + r_i)s$ ($i \in [1, m]$) and sends them to P_2 . r_i , known only by P_1 , is a random number in real domain.
- (b) She computes $e(-r_i)s$ ($i \in [1, m]$) and sends them to P_2 .

2. P_2 performs the following operations:

- (a) He computes $t_1 = e(x_{11} + r_1)^{x_{21}} = e(x_{11} \cdot x_{21} + r_1 x_{21})$, $t_2 = e(x_{12} + r_2)^{x_{22}} = e(x_{12} \cdot x_{22} + r_2 x_{22})$, \dots , $t_m = e(x_{1m} + r_m)^{x_{2m}} = e(x_{1m} \cdot x_{2m} + r_m x_{2m})$.
- (b) He computes $t_1 \times t_2 \times \dots \times t_m = e(x_{11} \cdot x_{21} + x_{12} \cdot x_{22} + \dots + x_{1m} \cdot x_{2m} + r_1 x_{21} + r_2 x_{22} + \dots + r_m x_{2m}) = e(\vec{x}_1 \cdot \vec{x}_2 + \sum_{i=1}^m r_i x_{2i})$.
- (c) He computes $e(-r_i)^{x_{2i}} = e(-r_i x_{2i})$ for $i \in [1, m]$.
- (d) He computes $e(\vec{x}_1 \cdot \vec{x}_2 + \sum_{i=1}^m r_i x_{2i}) \times e(-r_1 x_{21}) \times e(-r_2 x_{22}) \times \dots \times e(-r_m x_{2m}) = e(\vec{x}_1 \cdot \vec{x}_2)$.

We need to show that the above protocol is correct, and that it preserves the privacy of P_1 and P_2 as postulated in Sec. 3.1.

Lemma 1 (*Correctness*). *Protocol 1 correctly computes the inner product $(\vec{x}_1 \cdot \vec{x}_2)$ against semi-honest parties.*

Proof When P_2 receives each encrypted element $e(x_{1i} + r_i)$ and $e(-r_i)$, he computes $\sum_{i=1}^m e(x_{1i} + r_i)^{x_{2i}}$ which, according to Eq.(9), is equal to $e(\sum_{i=1}^m x_{1i} \cdot x_{2i} + \sum_{i=1}^m r_i x_{2i})$ for all $i \in [1, m]$. He then computes $e(\vec{x}_1 \cdot \vec{x}_2 +$

$\sum_{i=1}^m r_i x_{2i}) \times e(-r_1 x_{21}) \times e(-r_2 x_{22}) \times \cdots \times e(-r_m x_{2m}) = e(\vec{x}_1 \cdot \vec{x}_2)$ according to Eq.(8). After that, he sends it to P_1 who computes $d(e(\vec{x}_1 \cdot \vec{x}_2)) = (\vec{x}_1 \cdot \vec{x}_2)$. Therefore, $(\vec{x}_1 \cdot \vec{x}_2)$ is correctly computed. ■

Lemma 2 (Privacy-Preserving). *Assuming the parties follow the protocol, the private data are securely protected.*

Proof There are 2 points we need analyze. (1) Whether P_1 can obtain P_2 's private data. There is no information that P_2 sends to P_1 , thus, P_2 's private data cannot be disclosed to P_1 . (2) Whether P_2 can obtain P_1 's private data. What P_2 receives from P_1 is encrypted and masked element of P_1 's data. Since P_2 has no decryption key and doesn't know the random number used by P_1 , it is impossible that P_2 can obtain P_1 's private data. ■

Lemma 3 (Efficiency). *Protocol 1 is efficient from both computation and communication point of view.*

Proof To prove the efficiency, we need conduct complexity analysis of the protocol. The bit-wise communication cost of this protocol is $(2m + 1)\alpha$ where α is the number of bits for each transmitted element. The following contributes to the computational cost: (1) $2m$ encryptions; (2) $2m$ exponentiations; (2) $2m-1$ multiplications. Therefore, the protocol is sufficient fast. ■

V. Conclusion

In this paper, we consider the problem of collaboratively learning Support Vector Machines on private data. We develop a secure collaborative protocol based on semantically secure homomorphic encryption scheme. In our protocol, the parties do not need to send all their data to a central, trusted party. Instead, we use the homomorphic encryption and random perturbation techniques to conduct the computations across the parties without compromising their data privacy. As future work, we will develop secure protocols for the cases where more kernel functions are applied. We will also apply our technique to other data mining computations, such as secure collaborative clustering.

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Privacy-Preserving Naive Bayesian Classification Over Vertically Partitioned Data

Justin Zhan¹, Stan Matwin², and LiWu Chang³

^{1,2}School of Information Technology & Engineering, University of Ottawa, Canada

³Center for High Assurance Computer Systems, Naval Research Laboratory, USA

{zhizhan, stan}@site.uottawa.ca, lchang@itd.nrl.navy.mil

Abstract: Protection of privacy is a critical problem in data mining. Preserving data privacy in distributed data mining is even more challenging. In this paper, we consider the problem of privacy-preserving naive Bayesian classification over vertically partitioned data. The problem is one of important issues in privacy-preserving distributed data mining. Our approach is based on homomorphic encryption. The scheme is very efficient in the term of computation and communication cost.

Keywords: Privacy, security, naive Bayesian classification.

I. Introduction

Recent advances in computer networking and database technologies have resulted in creation of large quantities of data which are located in different sites. Data mining is a useful tool to extract valuable knowledge from this data. Well known data mining algorithms include association rule mining, classification, clustering, outlier detection, etc. However, extracting useful knowledge from distributed sites is often challenging due to real world constraints such as privacy, communication and computation overhead.

In this paper, we focus on privacy-preserving data mining in a distributed setting where the different sites have diverse sets of features. Specially, we consider the problem of privacy-preserving naive Bayesian classification that is one of the most successful algorithms in many classification domains. A Bayesian network is a high-level representation of a probability distribution over a set of variables that are used for constructing a model of the problem domain. It has been widely used in sales decision making, marketing systems, risk analysis, cost benefit factor inference in E-services, and other business applications. A Bayesian network have many applications. For instance it can be used to compute the predictive distribution on effects of possible actions since it

is a model of the problem domain probability distribution.

A naive Bayesian classifier is one of Bayesian classifiers under conditional independence assumption of different features. Over the last decade, the naive Bayesian classification has been widely utilized. Although the techniques that have been developed are effective, new techniques dealing with naive Bayesian classification over private data are required. In other words, we need methods to learn a naive Bayesian classifier over distributed private data. In this paper, we develop a novel scheme based on homomorphic encryption without compromising data privacy.

II. Related Work

In early work on privacy-preserving data mining, Lindell and Pinkas [13] propose a solution to privacy-preserving classification problem using oblivious transfer protocol, a powerful tool developed by secure multi-party computation (SMC) research [21, 10]. The techniques based on SMC for efficiently dealing with large data sets have been addressed in [20]. Randomization approaches were firstly proposed by Agrawal and Srikant in [2] to solve privacy-preserving data mining problem. Researchers proposed more random perturbation-based techniques to tackle the problems (e.g., [5, 18, 7]). In addition to perturbation, aggregation of data values [19] provides another alternative to mask the actual data values. In [1], authors studied the problem of computing the k th-ranked element. Dwork and Nissim [6] showed how to learn certain types of boolean functions from statistical databases in terms of a measure of probability difference with respect to probabilistic implication, where data are perturbed with noise for the release of statistics. The problem we are studying is actually a special case of a more general problem, the Secure Multi-party Computation (SMC) problem. Briefly, a SMC problem deals with computing any function on any input, in a distributed network where each participant holds one of the inputs, while ensuring that no more information is revealed to a participant in the computation than can be inferred from

that participant's input and output [12]. The SMC problem literature is extensive, having been introduced by Yao [21] and expanded by Goldreich, Micali, and Wigderson [11] and others [8]. It has been proved that for any function, there is a secure multi-party computation solution [10]. The approach used is as follows: the function F to be computed is first represented as a combinatorial circuit, and then the parties run a short protocol for every gate in the circuit. Every participant gets corresponding shares of the input wires and the output wires for every gate. This approach, though appealing in its generality and simplicity, means that the size of the protocol depends on the size of the circuit, which depends on the size of the input. This is highly inefficient for large inputs, as in data mining. It has been well accepted that for special cases of computations, special solutions should be developed for efficiency reasons.

III. Building Naive Bayesian Classifiers

III.1 Notations

- e : public key.
- d : private key.
- P_i : the i th party.
- n : the total number of parties. Assuming $n > 2$.
- m : the total number of class.
- α is the number of bits for each transmitted element in the privacy-preserving protocols.
- N : the total number of records.

III.2 Cryptography Tools

Our scheme is based on homomorphic encryption which was originally proposed in [17]. Since then, many such systems have been proposed [3, 14, 15, 16]. We observe that some homomorphic encryption schemes, such as [4], are not robust against chosen cleartext attacks. However, we base our secure protocols on [16], which is semantically secure [9].

In our secure protocols, we use additive homomorphism offered by [16]. In particular, we utilize the following characterizer of the homomorphic encryption functions: $e(a_1) \times e(a_2) = e(a_1 + a_2)$ where e is an encryption function; a_1 and a_2 are the data to be encrypted. Because of the property of associativity, $e(a_1 + a_2 + \dots + a_n)$ can be computed as $e(a_1) \times e(a_2) \times \dots \times e(a_n)$ where $e(a_i) \neq 0$. That is

$$d(e(a_1 + a_2 + \dots + a_n)) = d(e(a_1) \times e(a_2) \times \dots \times e(a_n)) \quad (1)$$

$$d(e(a_1)^{a_2}) = d(e(a_1 a_2)) \quad (2)$$

III.3 Introducing Naive Bayesian Classification

The naive Bayesian classification is one of the most successful algorithms in many classification domains. Despite of its simplicity, it is shown to be competitive with other complex approaches, especially in text categorization and content based filtering. The naive Bayesian classifier applies to learning tasks where each instance x is described by a conjunction of attribute values and where the target function $f(x)$ can take on any value from some finite set V . A set of training examples of the target function is provided, and a new instance is presented, described by the tuple of attribute values $\langle a_1, a_2, \dots, a_n \rangle$. The learner is asked to predict the target value for this new instance. Under a conditional independence assumption, i.e., $Pr(a_1, a_2, \dots, a_n | v_j) = \prod_{i=1}^n Pr(a_i | v_j)$, a naive Bayesian classifier can be derived as follows:

$$\begin{aligned} V_{NB} &= \operatorname{argmax}_{v_j \in V} Pr(v_j) \prod_{i=1}^n Pr(a_i | v_j) \\ &= \operatorname{argmax}_{v_j \in V} Pr(v_j) \prod_{i=1}^n \frac{Pr(a_i, v_j)}{Pr(v_j)} \end{aligned}$$

To build a NB classifier, we need to compute $Pr(v_j)$ and $Pr(a_i, v_j)$. $Pr(v_j)$ can be computed by the owner of v_j without breaching privacy. To compute $Pr(a_i, v_j)$, we need consider two aspects: (1) All the parties share the class label; (2) The class label is hosted by only one party. For the first case, $Pr(a_i, v_j)$ can be calculated by the owner of v_j without breaching privacy. For the second case, if the owner of v_j also owns the class label, he can compute $Pr(a_i, v_j)$. However, when a_i and v_j belong to different parties, the computation of $Pr(a_i, v_j)$ is challenging.

In this paper, we will design a privacy-preserving system to show how to compute a naive Bayesian classifier. The goal of our privacy-preserving classification system is to disclose no private data in every step. We firstly select a key generator who produces the encryption and decryption key pairs. The computation of the whole system is under encryption. For the purpose of illustration, let's assume that P_n is the key generator who generates a homomorphic encryption key pair (e, d) . The key generator should not host the class label. For the purpose of illustration, let's assume that P_1 holds the class label. Next, we will show how to conduct each step.

III.4 Privacy-Preserving Naive Bayesian Classification

III.4.1 To Compute $e(Pr(a_i, v_j))$

Protocol 1 .

1. P_l for $l \in [2, n]$ performs the following operations:
 - (a) She computes $e(a_{ik})$ s ($k \in [1, N]$) and sends them to P_1 .
2. P_1 performs the following operations:
 - (a) He computes $t_1 = e(a_{i1})^{v_{j1}} = e(a_{i1} \cdot v_{j1})$, $t_2 = e(a_{i2})^{v_{j2}} = e(a_{i2} \cdot v_{j2})$, \dots , $t_N = e(a_{iN})^{v_{jN}} = e(a_{iN} \cdot v_{jN})$.
 - (b) He computes $t_1 \times t_2 \times \dots \times t_N = e(a_{i1} \cdot v_{j1} + a_{i2} \cdot v_{j2} + \dots + a_{iN} \cdot v_{jN}) = e(\vec{a_i} \cdot \vec{v_j})$.
 - (c) He computes $e(\vec{a_i} \cdot \vec{v_j})^{\frac{1}{N}} = e(\frac{(\vec{a_i} \cdot \vec{v_j})}{N}) = e(Pr(a_i, v_j))$.

Theorem 1 (Correctness). *Protocol 1 correctly computes $e(Pr(a_i, v_j))$.*

Proof When P_1 receives $e(a_{ik})$ ($k \in [1, N]$), he computes $t_k = e(a_{ik})^{v_{jk}}$. According to Eq. 2, it is equal to $e(a_{ik}v_{jk})$ for $k \in [1, N]$. He then computes $\prod_{k=1}^N t_k$ which is equal to $e(\vec{a_i} \cdot \vec{v_j})$ according to Eq. 1. Finally, he computes $e(\vec{a_i} \cdot \vec{v_j})^{\frac{1}{N}} = e(Pr(a_i, v_j))$. Therefore, the protocol 1 correctly computes $e(Pr(a_i, v_j))$. ■

Theorem 2 (Privacy-Preserving). *Assuming the parties follow the protocol, the private data are securely protected.*

Proof In protocol 1, all the data transmission are hidden under encryption. The parties who are not the key generator can't see other parties' private data. On the other hand, the key generator doesn't obtain the encryption of other parties' private data. Therefore, protocol 1 discloses no private data. ■

Theorem 3 (Efficiency). *Protocol 1 is efficient in terms of computation and communication complexity.*

Proof To prove the efficiency, we need conduct complexity analysis of the protocol. The bit-wise communication cost of this protocol is amN . The computation cost is upper bounded by $(m+2)N$. Therefore, the protocol is sufficient fast. ■

Via the above protocol, the class holder P_1 gets $e(Pr(a_i, v_j))(P_l)$ for $l \in [2, n]$ and $e(Pr(a_i, v_j))(P_l)$ denotes $e(Pr(a_i, v_j))$ for l th party. Next, we will show how to construct a NB classifier.

III.4.2 To Compute $e(Pr(v_j) \prod_{i=1}^n \frac{Pr(a_i, v_j)}{Pr(v_j)})$ for each $v_j \in V$

Protocol 2 .

1. P_1 generates a set of random numbers, r_2, r_3, \dots , and r_n .
2. P_1 computes $e(Pr(a_i, v_j)(P_2)) \times e(r_2) = e(Pr(a_i, v_j)(P_2) + r_2)$, $e(Pr(a_i, v_j)(P_3)) \times e(r_3) = e(Pr(a_i, v_j)(P_3) + r_3)$, \dots , $e(Pr(a_i, v_j)(P_n)) \times e(r_n) = e(Pr(a_i, v_j)(P_n) + r_n)$.
3. P_1 sends $e(Pr(a_i, v_j)(P_l) + r_l)$ to P_n where $l \in [2, n]$.
4. P_n decrypts them and obtains $Pr(a_i, v_j)(P_l) + r_l$ for $l \in [2, n]$.
5. P_n sends $Pr(a_i, v_j)(P_l) + r_l$ to P_l for $l \in [2, n-1]$.
6. P_1 computes $e(\prod_{v_j \in P_1} \frac{Pr(a_i, v_j)}{Pr(v_j)})$ for $a_i \in P_1$. Let's denote it by $e(G_1)$. P_1 sends $e(G_1)$ to P_2 .
7. P_2 computes $e(G_1)^{(Pr(a_i, v_j)(P_2) + r_2)} = e((Pr(a_i + v_j)(P_2) + r_2) \times G_1)$ and sends it to P_1 .
8. P_1 computes $e((Pr(a_i + v_j)(P_2) + r_2) \times G_1) \times e(-r_2 G_1) = e(\prod_{a_i \in P_1, P_2} \frac{Pr(a_i, v_j)}{Pr(v_j)})$ denoted by $e(G_2)$.
9. Continue until P_1 gets $e(\prod_{a_i \in P_1, P_2, \dots, P_n} \frac{Pr(a_i, v_j)}{Pr(v_j)}) = e(\prod_{i=1}^n \frac{Pr(a_i, v_j)}{Pr(v_j)})$.
10. P_1 computes $e(\prod_{i=1}^n \frac{Pr(a_i, v_j)}{Pr(v_j)})^{Pr(v_j)} = e(Pr(v_j) \prod_{i=1}^n \frac{Pr(a_i, v_j)}{Pr(v_j)})$.

Theorem 4 (Correctness). *Protocol 2 correctly computes $e(Pr(a_i, v_j))$.*

Proof In step 3, P_n obtains $e(Pr(a_i, v_j)(P_l) + r_l)$ for $l \in [2, n]$. In step 6, P_1 computes $e(G_1) = e(\prod_{v_j \in P_1} \frac{Pr(a_i, v_j)}{Pr(v_j)})$ for $a_i \in P_1$ based on his own data. In step 9, P_1 obtains $e(G_2) = e((Pr(a_i + v_j)(P_2) + r_2) \times G_1) \times e(-r_2 G_1) = e(\prod_{a_i \in P_1, P_2} \frac{Pr(a_i, v_j)}{Pr(v_j)})$ according Eq. 1 and Eq. 2. Finally, P_1 obtains $e(\prod_{i=1}^n \frac{Pr(a_i, v_j)}{Pr(v_j)})^{Pr(v_j)} = e(Pr(v_j) \prod_{i=1}^n \frac{Pr(a_i, v_j)}{Pr(v_j)})$ according to Eq. 2. ■

Theorem 5 (Privacy-Preserving). *Assuming the parties follow the protocol, the private data are securely protected.*

Proof In protocol 2, all the data transmission, among the parties who have no decryption key, are hidden under encryption. Therefore, these parties cannot know the private data. In step 4, P_n obtains $Pr(a_i, v_j)(P_l) + r_l$ for

$l \in [2, n]$. Since it is hidden by a random number r_l known only by P_1 . P_n cannot get $Pr(a_i, v_j)(P_l)$. Therefore, protocol 2 discloses no private data. ■

Theorem 6 (Efficiency). *Protocol 2 is efficient in terms of computation and communication complexity.*

Proof The bit-wise communication cost of this protocol is upper bounded by $4n\alpha$. The computation cost is upper bounded by $8n$. Therefore, the protocol is sufficient fast. ■

Through the above protocol, $e(Pr(v_j) \prod_{i=1}^n \frac{Pr(a_i, v_j)}{Pr(v_j)})$ can be computed for each $v_j \in V$. Without loss of generality, let's assume P_1 gets $e(V_{NB_1})$, $e(V_{NB_2})$, \dots , $e(V_{NB_k})$. The goal is to find the largest one.

III.4.3 To Compute V_{NB}

Protocol 3 .

1. P_1 computes $e(V_{NB_i}) \times e(V_{NB_j})^{-1} = e(V_{NB_i} - V_{NB_j})$ for all $i, j \in [1, k], i > j$, and sends the sequence denoted by φ to P_n in a random order.
2. P_n decrypts each element in the sequence φ . He assigns the element $+1$ if the result of decryption is not less than 0, and -1 , otherwise. Finally, he obtains a $+1/-1$ sequence denoted by φ' .
3. P_n sends $+1/-1$ sequence φ' to P_1 who computes the largest element.

Theorem 7 (Correctness). *Protocol 3 correctly computes V_{NB} .*

Proof P_1 is able to remove permutation effects from φ' (the resultant sequence is denoted by φ'') since she has the permutation function that she used to permute φ , so that the elements in φ and φ'' have the same order. It means that if the q th position in sequence φ denotes $e(V_{NB_i} - V_{NB_j})$, then the q th position in sequence φ'' denotes the evaluation results of $V_{NB_i} - V_{NB_j}$. We encode it as $+1$ if $V_{NB_i} \geq V_{NB_j}$, and as -1 otherwise. P_1 has two sequences: one is the φ , the sequence of $e(V_{NB_i} - V_{NB_j})$, for $i, j \in [1, k] (i > j)$, and the other is φ'' , the sequence of $+1/-1$. The two sequences have the same number of elements. P_1 knows whether or not V_{NB_i} is larger than V_{NB_j} by checking the corresponding value in the φ'' sequence. For example, if the first element φ'' is -1 , P_1 concludes $V_{NB_i} < V_{NB_j}$. P_1 examines the two sequences and constructs the index table (Table 1) to compute the largest element.

In Table 1, $+1$ in entry ij indicates that the information gain of the row (e.g., V_{NB_i} of the i th row) is not less than the information gain of a column (e.g., V_{NB_j} of

	V_{NB_1}	V_{NB_2}	V_{NB_3}	\dots	V_{NB_k}
V_{NB_1}	$+1$	$+1$	-1	\dots	-1
V_{NB_2}	-1	$+1$	-1	\dots	-1
V_{NB_3}	$+1$	$+1$	$+1$	\dots	$+1$
\dots	\dots	\dots	\dots	\dots	\dots
V_{NB_k}	$+1$	$+1$	-1	\dots	$+1$

Table 1:

	S_1	S_2	S_3	S_4	Weight
S_1	$+1$	-1	-1	-1	-2
S_2	$+1$	$+1$	-1	$+1$	$+2$
S_3	$+1$	$+1$	$+1$	$+1$	$+4$
S_4	$+1$	-1	-1	$+1$	0

Table 2:

the j th column); -1 , otherwise. P_1 sums the index values of each row and uses this number as the weight of the information gain in that row. She then selects the one that corresponds to the largest weight.

To make it clearer, let's illustrate it by an example. Assume that: (1) there are 4 information gains with $V_{NB_1} < V_{NB_4} < V_{NB_2} < V_{NB_3}$; (2) the sequence φ is $[e(V_{NB_1} - V_{NB_2}), e(V_{NB_1} - V_{NB_3}), e(V_{NB_1} - V_{NB_4}), e(V_{NB_2} - V_{NB_3}), e(V_{NB_2} - V_{NB_4}), e(V_{NB_3} - V_{NB_4})]$. The sequence φ'' will be $[-1, -1, -1, -1, +1, +1]$. According to φ and φ'' , P_1 builds the Table 2. From the table, P_1 knows V_{NB_3} is the largest element since its weight, which is $+4$, is the largest. ■

Theorem 8 (Privacy-Preserving). *Assuming the parties follow the protocol, the private data are securely protected.*

Proof In protocol 3, we need prove it from two aspects: (1) P_1 doesn't get information gain (e.g., V_{NB_i}) for each attribute. What P_1 gets are $e(V_{NB_i} - V_{NB_j})$ for all $i, j \in [1, k], i > j$ and $+1/-1$ sequence. By $e(V_{NB_i} - V_{NB_j})$, P_1 cannot know each information gain since it is encrypted. By $+1/-1$ sequence, P_1 can only know whether or not V_{NB_i} is greater than P_j . (2) P_n doesn't obtain information gain for each attribute either. Since the sequence of $e(V_{NB_i} - V_{NB_j})$ is randomized before being send to P_n who can only know the sequence of $V_{NB_i} - V_{NB_j}$, he can't get each individual information gain. Thus private data are not revealed. ■

Theorem 9 (Efficiency). *The computation of protocol 3 is efficient from both computation and communication point of view.*

Proof The total communication cost is upper bounded by αm^2 . The total computation cost is upper bounded by $m^2 + m + 1$. Therefore, the protocols are very fast. ■

IV. Overall Discussion

Our privacy-preserving classification system contains several components. In Section , we show how to correctly compute $e(Pr(a_i, v_j))$. In Section , we present protocols to compute $e(Pr(v_j) \prod_{i=1}^n \frac{Pr(a_i, v_j)}{Pr(v_j)})$ for each $v_j \in V$. In Section , we show how to compute the final naive Bayesian classifier. We discussed the correctness of the computation in each section. Overall correctness is also guaranteed.

As for the privacy protection, all the communications between the parties are encrypted, therefore, the parties who has no decryption key cannot gain anything out of the communication. On the other hand, there are some communication between the key generator and other parties. Although the communications are still encrypted, the key generator may gain some useful information. However, we guarantee that the key generator cannot gain the private data by adding random numbers in the original encrypted data so that even if the key generator get the intermediate results, there is little possibility that he can know the intermediate results. Therefore, the private data are securely protected with overwhelming probability.

In conclusion, we provide a novel solution for naive Bayesian classification over vertically partitioned private data. Instead of using data transformation, we define a protocol using homomorphic encryption to exchange the data while keeping it private. Our classification system is quite efficient that can be envisioned by the communication and computation complexity. The total communication complexity is upper bounded by $\alpha(mN + m^2 + 4n)$. The computation complexity is upper bounded by $mN + 2N + 8n + m^2 + m + 1$.

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Privacy-Preserving Sequential Pattern Mining Over Vertically Partitioned Data

Justin Zhan¹, Stan Matwin², LiWu Chang³

^{1,2}School of Information Technology & Engineering, University of Ottawa, Canada

³Center for High Assurance Computer Systems, Naval Research Laboratory, USA

{zhizhan, stan}@site.uottawa.ca, lchang@itd.nrl.navy.mil

Abstract: Privacy-preserving data mining in distributed environments is an important issue in the field of data mining. In this paper, we study how to conduct sequential patterns mining, which is one of the data mining computations, on private data in the following scenario: Multiple parties, each having a private data set, want to jointly conduct sequential pattern mining. Since no party wants to disclose its private data to other parties, a secure method needs to be provided to make such a computation feasible. We develop a practical solution to the above problem in this paper.

Keywords: Privacy, security, sequential pattern mining.

I. Introduction

Data mining and knowledge discovery in databases is an important research area that investigates the automatic extraction of previously unknown patterns from large amounts of data. They connect the three worlds of databases, artificial intelligence and statistics. The information age has enabled many organizations to gather large volumes of data. However, the usefulness of this data is negligible if meaningful information or knowledge cannot be extracted from it. Data mining and knowledge discovery, attempts to answer this need. In contrast to standard statistical methods, data mining techniques search for interesting information without demanding a priori hypotheses. As a field, it has introduced new concepts and are becoming more and more popular with time.

One of important computations is sequential pattern mining [1, 8, 2, 7, 3], which is concerned of inducing rules from a set of sequences of ordered items. The main computation in sequential pattern mining is to calculate the support measures of sequences by iteratively joining those sub-sequences whose supports exceed a given threshold. In each of above works, an algorithm is provided to conduct such a computation assume that the

original data are available. However, conducting such a mining without knowing the original data is challenging.

Generic solutions for any kind of secure collaborative computing exist in the literature [4, 5, 6]. These solutions are the results of the studies of the Secure Multi-party computation problem [9, 5, 6, 4], which is a more general form of secure collaborative computing. However, the proposed generic solutions are usually impractical. They are not scalable and cannot handle large-scale data sets because of the prohibitive extra cost in protecting data secrecy. Therefore, practical solutions need to be developed. This need underlies the rationale for our research.

The paper is organized as follows: Section 2 discusses the related work. We then formally defines the mining sequential patterns on private data problem in Section 3. In Section 4, we describe our secure protocols. Section 5 analyzes the security and communication cost of our solution. We give our conclusion in Section 6.

II. Mining Sequential Patterns on Private Data

II.1 Background

Data mining includes a number of different tasks. This paper studies the sequential pattern mining problem. Since its introduction in 1995 [1], the sequential pattern mining has received a great deal of attention. It is still one of the most popular pattern-discovery methods in the field of Knowledge Discovery. Sequential pattern mining provides a means for discovering meaningful sequential patterns among a large quantity of data. For example, let us consider the sales database of a bookstore. The discovered sequential pattern could be like “70% of people who bought Harry Potter also bought Lord of Ring at a later time”. The bookstore can use this information for shelf placement, promotions, etc.

In the sequential pattern mining, we are given a database D of customer transactions. Each transaction consists of the following fields: customer-ID, transaction-time, and the items purchased in the transaction. No

customer has more than one transaction with the same transaction-time. We do not consider quantities of items bought in a transaction: each item is a binary variable representing whether an item was bought or not. An itemset is a non-empty set of items. A sequence is an ordered list of itemsets. A customer support is a sequence s if s is contained in the customer-sequence for this customer. The support for a sequence is defined as the fraction of total customers who support this sequence. Given a database D of customer transactions, the problem of mining sequential patterns is to find the maximal sequences among all sequences that have a certain user-specified minimum support. Each such maximal sequence represents a sequential pattern.

Mining Sequential Patterns On Private Data

problem: Party 1 has a private data set D_1 , party 2 has a private data set D_2 , \dots , and party n has a private data set D_n , data set $[D_1 \cup D_2 \cup \dots \cup D_n]$ is the union of D_1 , D_2 , \dots , and D_n (by vertically putting D_1 , D_2 , \dots , and D_n together.)* Let N be a set of transactions with N_k representing the k th transaction. These n parties want to conduct the sequential pattern mining on $[D_1 \cup D_2 \cup D_3 \dots \cup D_n]$ and to find the sequential patterns with support greater than the given threshold, but they do not want to share their private data sets with each other. We say that a sequential pattern of $x_i \leq y_j$, where x_i occurs before or at the same time as y_j , has support s in $[D_1 \cup D_2 \cup \dots \cup D_n]$ if $s\%$ of the transactions in $[D_1 \cup D_2 \dots \cup D_n]$ contain both x_i and y_j with x_i happening before or at the same time as y_j (namely, $s\% = Pr(x_i \leq y_j)$).

II.2 Sequential Pattern Mining Procedure

The procedure of mining sequential patterns contains the following steps:

Step I: Sorting

The database $[D_1 \cup D_2 \dots \cup D_n]$ is sorted, with customer ID as the major key and transaction time as the minor key. This step implicitly converts the original transaction database into a database of customer sequences. As a result, transactions of a customer may appear in more than one row which contains information of a customer ID, a particular transaction time and items bought at this transaction time. For example, suppose that datasets after being sorted by their customer-ID numbers are shown in Fig. 1. Then after being sorted by the transaction time, data tables of Fig. 1 will become those of Fig. 2.

*Vertically partitioned datasets are also called heterogeneous partitioned datasets where different datasets contain different types of items with customer IDs are identical for each transaction.

Step II: Mapping

Each item of a row is considered as an attribute. We map each item of a row (i.e., an attribute) to an integer in an increasing order and repeat for all rows. Re-occurrence of an item will be mapped to the same integer. As a result, each item becomes an attribute and all attributes are binary-valued. For instance, the sequence $\langle B, (A, C) \rangle$, indicating that the transaction B occurs prior to the transaction (A, C) with A and C occurring together, will be mapped to integers in the order $B \rightarrow 1$, $A \rightarrow 2$, $C \rightarrow 3$, $(A, C) \rightarrow 4$. During the mapping, the corresponding transaction time will be kept. For instance, based on the sorted dataset of Fig. 2, we may construct the mapping table as shown in Fig. 3. After the mapping, the mapped datasets are shown in Fig. 4.

Step III: Mining

Our mining procedure will be based on mapped dataset. The general sequential pattern mining procedure contains multiple passes over the data. In each pass, we start with a seed set of large sequences, where a large sequence refers to a sequence whose itemsets all satisfy the minimum support. We utilize the seed set for generating new potentially large sequences, called candidate sequences. We find the support for these candidate sequences during the pass over the data. At the end of each pass, we determine which of the candidate sequences are actually large. These large candidates become the seed for the next pass.

The following is the procedure for mining sequential patterns on $[D_1 \cup D_2 \dots \cup D_n]$.

1. L_1 = large 1-sequence
2. for ($k = 2$; $L_{k-1} \neq \phi$; $k++$) do{
3. C_k = **apriori-generate**(L_{k-1})
4. for all candidates $c \in C_k$ do {
5. **Compute** $c.count$
 (Section will show how to compute this count on private data)
6. $L_k = L_k \cup c \mid c.count \geq minsup$
7. end
8. end
9. Return $U_k L_k$

where L_k stands for a sequence with k itemsets and C_k stands for the collection of candidate k -sequences. The procedure **apriori-generate** is described as follows:

First: join L_{k-1} with L_{k-1} :

1. insert into C_k
2. select $p.litemset_1, \dots, p.litemset_{k-1},$
 $q.litemset_{k-1}$, where $p.litemset_1 = q.litemset_1,$
 $\dots,$
 $p.litemset_{k-2} = q.litemset_{k-2}$
3. from L_{k-1} p, L_{k-1} q.

Alice			Bob			Carol	
C-ID	T-time	Items Bought	C-ID	T-time	Items Bought	C-ID	T-time
1	06/25/03	30	1	06/30/03	90	1	06/28/03
2	06/10/03	10, 20	2	06/15/03	40, 60	2	06/13/03
2	06/20/03	9, 15	3	06/18/03	35, 50	3	06/19/03
3	06/25/03	30	3	06/10/03	45, 70	3	06/21/03
3	06/30/03	5, 10				3	06/26/03

Figure 1: Raw Data Sorted By Customer ID

Alice			Bob			Carol		
C-ID	T-time	Items Bought	C-ID	T-time	Item Bought	C-ID	T-time	Item Bought
1	06/25/03	30	N/A			N/A		
N/A			N/A			1	06/28/03	110
N/A			1	06/30/03	90	N/A		
2	06/10/03	10, 20	N/A			N/A		
N/A			N/A			2	06/13/03	107
N/A			2	06/15/03	40, 60	N/A		
2	06/20/03	9, 15	N/A			N/A		
N/A			3	06/10/03	45, 70	N/A		
N/A			3	06/18/03	35, 50	N/A		
N/A			N/A			3	06/19/03	103
N/A			N/A			3	06/21/03	101, 102
3	06/25/03	30	N/A			N/A		
N/A			N/A			3	06/26/03	105, 106
3	06/30/03	5, 10	N/A			N/A		

N/A: The information is not available.

Figure 2: Raw Data Sorted By Customer ID and Transaction Time

Second: delete all sequences $c \in C_k$ such that some $(k-1)$ -subsequence of c is not in L_{k-1} .

Step IV: Maximization

Having found the set of all large sequences S , we provide the following procedure to find the maximal sequences.

1. for $(k = m; k \geq 1; k--)$ **do**
2. for each k -sequence s_k **do**
3. **Delete** all subsequences of s_k from S

Step V: Converting

The items in the final large sequences are converted back to the original item representations used before the mapping step. For example, if 1A belongs to some large

sequential pattern, then 1A will be converted to item 30, according to the mapping table, in the final large sequential patterns.

II.3 How to compute $c.count$

To compute $c.count$, in other words, to compute the support for some candidate pattern (e.g., $P(x_i \cap y_i \cap z_i | x_i \geq y_i \geq z_i)$), we need to conduct two steps: one is to deal with the condition part where z_i occurs before y_i and both of them occur before x_i ; the other is to compute the actual counts for this sequential pattern.

If all the candidates belong to one party, then $c.count$, which refers to the frequency counts for candidates, can be computed by this party since this party has all the information needed to compute it. However, if the can-

Alice	30 - 1A	10 - 2A	20 - 3A	(10, 20) - 4A	9 - 5A	15 - 6A	(9, 15) - 7A	5
Bob	90 - 1B	40 - 2B	60 - 3B	(40, 60) - 4B	35 - 5B	50 - 6B	(35, 50) - 7B	4
Carol	110 - 1C	107 - 2C	103 - 3C	101 - 4C	102 - 5C	(101,102)- 6C	105 - 7C	10

Note that, in Alice's dataset, item 30 and 10 are reoccurred, so we map them to the same mapped-ID.

Figure 3: Mapping Table

Alice															
Mapped C-ID \ ID	1A		2A		3A		4A		5A		6A		7A		8
1	1	06/25/03	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0
2	0	N/A	1	06/10/03	1	06/10/03	1	06/10/03	1	06/20/03	1	06/20/03	1	06/20/03	0
3	1	06/25/03	1	06/30/03	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	1

Bob															
Mapped C-ID \ ID	1B		2B		3B		4B		5B		6B		7B		8B
1	1	06/30/03	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0
2	0	N/A	1	06/15/03	1	06/15/03	1	06/15/03	0	N/A	0	N/A	0	N/A	0
3	0	N/A	0	N/A	0	N/A	0	N/A	1	06/18/03	1	06/18/03	1	06/10/03	1

Carol															
Mapped C-ID \ ID	1C		2C		3C		4C		5C		6C		7C		8C
1	1	06/28/03	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0
2	0	N/A	1	06/13/03	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0
3	0	N/A	0	N/A	1	06/19/03	1	06/21/03	1	06/21/03	1	06/21/03	1	06/26/03	1

N/A : The information is not available.

Figure 4: Data After Being Mapped

didates belong to different parties, it is a non-trivial task to conduct the joint frequency counts while protecting the security of data. We provide the following steps to conduct this cross-parties' computation.

II.3.1 Vector Construction

The parties construct vectors for their own attributes (mapped-ID). In each vector constructed from the mapped dataset, there are two components: one consists of the binary values (called the value vector); the other consists of the transaction time (called the transaction time vector). Suppose we want to compute the $c.count$ for $2A \geq 2B \geq 6C$ in Fig. 4. We construct three vectors: $2A$, $2B$ and $6C$ depicted in Fig. 5.

II.3.2 Transaction time comparison

To compare the transaction time, each time vector should have a value. We let all the parties randomly generate a set of transaction time for entries in the vector where their values are 0's. They then transform their values in time vector into real numbers so that if transaction tr_1 happens earlier than the transaction tr_2 , then the real number to denote tr_1 should smaller than the number that denotes tr_2 . For instance, "06/30/2003" and "06/18/2003" can be transform to 363 and 361.8 respectively. The purpose of transformation is that we will securely compare them based their real number denotation. The comparison can be conducted pairwise. Next, we will present a secure protocol that allows n parties to compare their transaction time.

The goal of our privacy-preserving classification sys-

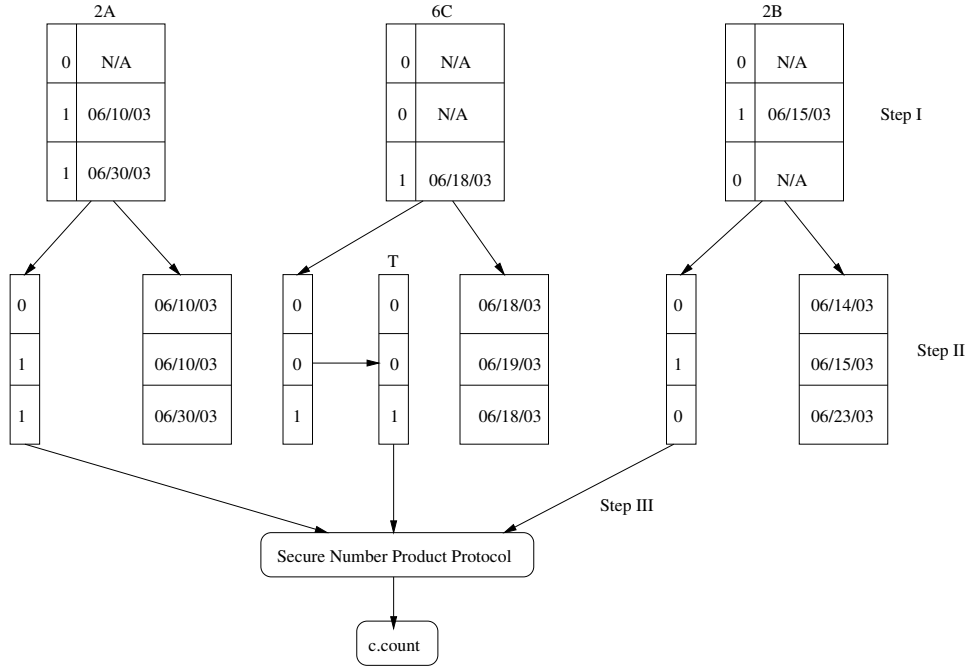


Figure 5: An Protocol To Compute c.count

tem is to disclose no private data in every step. We firstly select a key generator who produces the encryption and decryption key pairs. The computation of the whole system is under encryption. For the purpose of illustration, let's assume that P_n is the key generator who generates a homomorphic encryption key pair (e, d) . Next, we will show how to conduct each step.

II.3.3 The Comparison of Transaction Time

Without loss of generality, assuming there are k transaction time: $e(g_1)$, $e(g_2)$, \dots , and $e(g_k)$, with each corresponding to a transaction of a particular party.

Protocol 1 .

1. P_{n-1} computes $e(g_i) \times e(g_j)^{-1} = e(g_i - g_j)$ for all $i, j \in [1, k], i > j$, and sends the sequence denoted by φ to P_n in a random order.
2. P_n decrypts each element in the sequence φ . He assigns the element $+1$ if the result of decryption is not less than 0, and -1 , otherwise. Finally, he obtains a $+1/-1$ sequence denoted by φ' .
3. P_n sends $+1/-1$ sequence φ' .
4. P_{n-1} compares the transaction time of each entry of vectors such as 2A, 2B, and 6C in our example. She makes a temporary vector T . If the transaction time does not satisfy the requirement of $2A \geq 2B \geq 6C$, she sets the corresponding entries of T to 0's;

otherwise, she copies the original values in 6C to T (Fig. 5).

Theorem 1 (Correctness). Protocol 1 correctly sort the transaction time.

Proof P_{n-1} is able to remove permutation effects from φ' (the resultant sequence is denoted by φ'') since she has the permutation function that she used to permute φ , so that the elements in φ and φ'' have the same order. It means that if the q th position in sequence φ denotes $e(g_i - g_j)$, then the q th position in sequence φ'' denotes the evaluation results of $g_i - g_j$. We encode it as $+1$ if $g_i \geq g_j$, and as -1 otherwise. P_{n-1} has two sequences: one is the φ , the sequence of $e(g_i - g_j)$, for $i, j \in [1, k] (i > j)$, and the other is φ'' , the sequence of $+1/-1$. The two sequences have the same number of elements. P_{n-1} knows whether or not g_i is larger than g_j by checking the corresponding value in the φ'' sequence. For example, if the first element φ'' is -1 , P_{n-1} concludes $g_i < g_j$. P_{n-1} examines the two sequences and constructs the index table (Table 1) to compute the largest element.

In Table 1, $+1$ in entry ij indicates that the value of the row (e.g., g_i of the i th row) is not less than the value of a column (e.g., g_j of the j th column); -1 , otherwise. P_{n-1} sums the index values of each row and uses this number as the weight of the information gain in that row. She then sorts the sequence according the weight.

To make it clearer, let's illustrate it by an example. Assume that: (1) there are 4 elements with $g_1 < g_4 <$

	g_1	g_2	g_3	\dots	g_k
g_1	+1	+1	-1	\dots	-1
g_2	-1	+1	-1	\dots	-1
g_3	+1	+1	+1	\dots	+1
\dots	\dots	\dots	\dots	\dots	\dots
g_k	+1	+1	-1	\dots	+1

Table 1:

	S_1	S_2	S_3	S_4	Weight
S_1	+1	-1	-1	-1	-2
S_2	+1	+1	-1	+1	+2
S_3	+1	+1	+1	+1	+4
S_4	+1	-1	-1	+1	0

Table 2:

$g_2 < g_3$; (2) the sequence φ is $[e(g_1 - g_2), e(g_1 - g_3), e(g_1 - g_4), e(g_2 - g_3), e(g_2 - g_4), e(g_3 - g_4)]$. The sequence φ'' will be $[-1, -1, -1, -1, +1, +1]$. According to φ and φ'' , P_{n-1} builds the Table 2. From the table, P_{n-1} knows $g_3 > g_2 > g_4 > g_1$ since g_3 has the largest weight, g_2 has the second largest weight, g_4 is third largest weight, g_1 has the smallest weight. ■

Theorem 2 (Privacy-Preserving). *Assuming the parties follow the protocol, the private data are securely protected.*

Proof We need prove it from two aspects: (1) P_{n-1} doesn't get transaction time (e.g., g_i) for each vector. What P_{n-1} gets are $e(g_i - g_j)$ for all $i, j \in [1, k], i > j$ and $+1/-1$ sequence. By $e(g_i - g_j)$, P_{n-1} cannot know each transaction time since it is encrypted. By $+1/-1$ sequence, P_{n-1} can only know whether or not g_i is greater than P_j . (2) P_n doesn't obtain transaction time for each vector either. Since the sequence of $e(g_i - g_j)$ is randomized before being send to P_n who can only know the sequence of $g_i - g_j$, he can't get each individual transaction time. Thus private data are not revealed. ■

Theorem 3 (Efficiency). *The computation of protocol 1 is efficient from both computation and communication point of view.*

Proof The total communication cost is upper bounded by αm^2 . The total computation cost is upper bounded by $m^2 + m + 1$. Therefore, the protocols are very fast. ■

After the above step, they need to compute $c.count$ based their value vector. For example, to obtain $c.count$ for $2A \geq 2B \geq 6C$ in Fig. 5, they need to compute $\sum_{i=1}^N 2A[i] \cdot 2B[i] \cdot T[i] = \sum_{i=1}^N 2A[i] \cdot 2B[i] \cdot T[i] = \sum_{i=1}^3 2A[i] \cdot 2B[i] \cdot T[i] = 0$, where N is the total number of

values in each vector. In general, let's assume the value vectors for P_1, \dots, P_n are x_1, \dots, x_n respectively. Note that P_1 's vector is T . For the purpose of illustration, we denote T by x_{n-1} . Next, we will show how n parties compute this count. without revealing their private data to each other.

II.3.4 The Computation of $c.count$

Protocol 2 Privacy-Preserving Number Product Protocol

1. P_n sends $e(x_{n1})$ to P_1 .
2. P_1 computes $e(x_{n1})^{x_{11}} = e(x_{n1}x_{11})$, then sends it to P_2 .
3. P_2 computes $e(x_{n1}x_{11})^{x_{21}} = e(x_{n1}x_{11}x_{21})$.
4. Continue until P_{n-1} obtains $e(x_{11}x_{21} \dots x_{n1})$.
5. Repeat all the above steps for x_{1i}, x_{2i}, \dots , and x_{ni} until P_{n-1} gets $e(x_{1i}x_{2i} \dots x_{ni})$ for all $i \in [1, N]$.
6. P_{n-1} computes $e(x_{11}x_{21} \dots x_{n1}) \times e(x_{12}x_{22} \dots x_{n2}) \times \dots \times e(x_{1N}x_{2N} \dots x_{nN}) = e(x_{11}x_{21} \dots x_{n1} + x_{12}x_{22} \dots x_{n2} + \dots + x_{1N}x_{2N} \dots x_{nN}) = c.count$.

Theorem 4 (Correctness). *Protocol 2 correctly compute $c.count$.*

Proof In step 2, P_1 obtains $e(x_{n1})$. He then computes $e(x_{n1}x_{11})$. In step 3, P_2 computes $e(x_{n1}x_{11}x_{21})$. Finally, in step 5, P_{n-1} gets $e(x_{1i}x_{2i} \dots x_{ni})$. He then computes $e(x_{11}x_{21} \dots x_{n1}) \times e(x_{12}x_{22} \dots x_{n2}) \times \dots \times e(x_{1N}x_{2N} \dots x_{nN}) = e(x_{11}x_{21} \dots x_{n1} + x_{12}x_{22} \dots x_{n2} + \dots + x_{1N}x_{2N} \dots x_{nN})$ which is equal to $c.count$. ■

Theorem 5 (Privacy-Preserving). *Assuming the parties follow the protocol, the private data are securely protected.*

Proof In protocol 2, all the data transmission are hidden under encryption. The parties who are not the key generator can't see other parties' private data. On the other hand, the key generator doesn't obtain the encryption of other parties's private data. Therefore, protocol 2 discloses no private data. ■

Theorem 6 (Efficiency). *The computation of $c.count$ is efficient from both computation and communication point of view.*

Proof To prove the efficiency, we need conduct complexity analysis of the protocol. The bit-wise communication cost of protocol 2 is $\alpha(n-1)N$. The computation cost of protocol 2 is nN , of protocol 2 is $5t+3$. The total computation cost is upper bounded by $nN-1$. Therefore, the protocols are sufficient fast. ■

III. Overall Discussion

Our privacy-preserving classification system contains several components. In Section , we show how to correctly compare the transaction time. In Section , we present protocols to compute *c.count*. We discussed the correctness of the computation in each section.

As for the privacy protection, all the communications between the parties are encrypted, therefore, the parties who has no decryption key cannot gain anything out of the communication. On the other hand, there are some communication between the key generator and other parties. Although the communications are still encrypted, the key generator may gain some useful information. However, we guarantee that the key generator cannot gain the private data by adding random numbers in the original encrypted data so that even if the key generator get the intermediate results, there is little possibility that he can know the intermediate results. Therefore, the private data are securely protected with overwhelming probability.

In summary, we provide a novel solution for sequential pattern mining over vertically partitioned private data. Instead of using data transformation, we define a protocol using homomorphic encryption to exchange the data while keeping it private. Our mining system is quite efficient that can be envisioned by the communication and computation complexity. The total communication complexity is upper bounded by $\alpha(nN+m^2-N)$. The computation complexity is upper bounded by $m^2+m+5t+4$.

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Mpdtn: A Novel Mobile Payment Scheme for Secure and Private Transactions

Kuen-Liang Sue, Chung-Hsien Tsai

Department of Information Management, National Central University

Jhongli City, Taoyuan County, Taiwan

Tel.+886-3-4267270

Email: klsue@mgt.ncu.edu.tw, 93423002@cc.ncu.edu.tw }

Abstract: Mobile commerce is becoming more and more popular which makes it possible to purchase goods and services anywhere and anytime. However, traditional payment schemes do not suffice for our demand as more novel commercial services were provided. Therefore, it's urgent to construct a safer and more convenient payment scheme for the forthcoming mobile era.

A mobile payment scheme is proposed in the paper. The scheme called MPDTN provides an ideal mobile payment with dynamic transaction numbers. Through it, consumers can pay fares by using mobile phones no matter in real store or virtual shop. Besides explaining our payment architecture and processes in detail, evaluation of the MPDTN's security from the aspect of defender and different roles of the attackers is provided in the paper. The investigation shows that, MPDTN can not only satisfy security criteria of confidence, integrity, authentication, and non-repudiation but also provide full transaction privacy to consumers.

Keywords: Security and Privacy, Mobile payment.

I. Introduction

Internet has become an indispensable part of our daily life. Various e-commerce including auction, e-shop, entertainment, etc. grows fast. More and more services can be provided via Internet. At the meanwhile, payment is becoming an important issue of the research about E-commerce.

On the other hand, mobile phones become more and more popular with the developing of mobile devices and telecommunication technologies. For example, each person has at least one mobile phone in Taiwan [1]. Besides, Wireless Application Protocol (WAP) and Wireless Markup Language (WML) makes the dream of surfing the internet through mobile devices come true [2]-[6]. Many commercial applications and services are developed and integrated into cell phones. The convenience of cell phone makes it possible to transact without restriction of time and place. The feature seems to explore the door of mobile commerce and attract consumer's eyes. The convenient and secure payment tool will play an important role during the evolution of m-commerce

Furthermore, the traditional plastic and electronic

currencies, such as credit card, smart card, or e-cash, have critical shortcomings that we have to overcome. Hackers or attackers can easily pretend to be the legal users and consume at will if they get the credit card numbers and the expiration date. The existing hole of security causes great losses to merchants, consumers, and banks. Most of important, the untrustworthy feeling restrains the development of novel payment tools and e-commerce.

In order to promote the m-commerce and improve existing payment schemes, the securer and more convenient payment tools are needed urgently. Due to the highly popular mobile phones and the well-developed telecommunication technology, payment via handsets is becoming a visual trend other than a dream. More and more investigations focus on the important issue. People expect that handset can do anything - no wallet and no cards.

A mobile payment scheme by using mobile phone is proposed in the paper. Mobile phones are the main payment media for transactions in the scheme. To reduce the risk of security and provide the user with higher privacy, the scheme called MPDTN provides the idea of "Mobile Payment with Dynamic Transaction Number". The second section introduces some of the existing mobile payment mechanisms. The third part goes into detail about MPDTN mechanism and its architecture. Evaluation of MPDTN's security from different points of view is investigated in section four. Finally, conclusions and possible future research are provided.

II. Related Works

Before introducing our model, we first review some existing mobile payment mechanisms and discuss their advantages and disadvantages.

Considering the transaction cost and the convenience, some mobile payment mechanisms using credit card numbers were proposed. Li used consumer's personal cell phone number as the transaction code instead of credit card number [7]. The author claimed that cell phones should take the place of credit cards when making transaction because of the convenience and the security of cell phone.

Step1: Li's payment process can be depicted as Fig.1. It includes the functions which the participators performed and the information transferred between participators. The process of Fig. 1 is illustrated as follows:

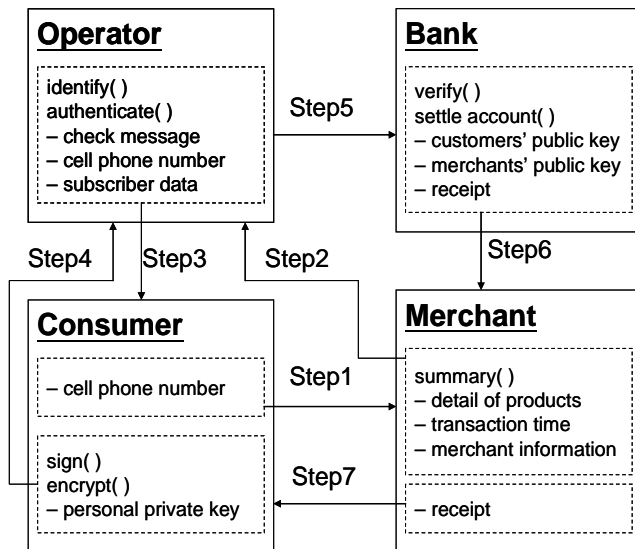


Fig. 1 Process of mobile credit payment

- Step2:** The consumer can buy products in the real store or the web store, and gives the seller his cell phone number. The merchant summarizes the transaction-related information, such as the product's ID, the transaction date and the customer's cell phone number. This activity is represented by the notation "summary()". Then, through wired network, he submits these data to the USSD (Unstructured Supplementary Service Data) sever of telecommunication service provider.
- Step3:** The operator then makes an USSD connection with the consumer through the phone number, and confirms the transaction information with the consumer after authentication.
- Step4:** After the consumer confirms the transaction information, he will use his personal private key which is stored in the SIM card of the mobile phone to sign the transaction data, and transfer the data back to the operator.
- Step5:** The operator delivers the signed transaction data to the cooperative bank.
- Step6:** The bank uses the consumer's public key to verify the consumer's identity and then checks his credit line. The bank also verifies the certificate of the merchant at the same time. After the verification, the bank deals with the transaction and transfers the receipt to the merchant.
- Step7:** The consumers get the result of the transaction from the merchant.

The advantage of the payment mechanism mentioned above is that we can reduce the consumers' risk even if the phone number is eavesdropped. Usually, it is very risky that consumers provide the credit card number and expiration date when paying with credit card. Besides, the usage of the digital signature in the SIM card can prevent the consumer identity from being forged.

Nowadays, transaction privacy that consumer desired is more and more emphasized. We cannot guarantee the privacy when making transactions by a consumer's phone number. Merchants may gather the consumer's consuming habits or promote their new products by sending messages if they know the phone numbers of the customers. This will bother the consumers to certain extent. Hence, how the payment mechanism provides the transaction privacy cannot be ignored.

Su designed and implemented a mobile payment system with high flexibility [8]. His proposal for mobile payment is similar to the mechanism mentioned before. When the customer transacts, he transferred a fixed "User Identification" to merchant instead of phone number. The merchant summarizes the transaction data and submits it to the operator. Then the operator confirms the transaction to the consumer through the phone number of the corresponding user identification.

Although consumers own their purchasing privacy to some degree by using the "User Identification", the operator still control the private transaction information. Moreover, because the "User Identification" is fixed, the merchants still can collect the consuming habits of certain customer. Therefore, we propose a mobile payment mechanism which not only satisfies the conditions of security, such as confidence, integrity, and non-repudiation, but also provide full transaction privacy by making use of dynamic transaction number. Rubin and Wright proposed a scheme in which a dynamic and limited-lifetime credit card number through symmetric encryption is used [9]. Since the credit card number can just be used a few times, it reduces the security risk. Considering the characteristics of our payment scenario, we adopt the asymmetric encryption protocol to produce a dynamic transaction number, and we believe that it can provide the consumer with the complete privacy during the whole transaction process.

III. Mpdtn Mechanism

The mobile payment mechanism we proposed uses the "dynamic transaction number" to ensure the confidence and privacy. The participators in the transaction process include the merchants, operators, and banks. We have two assumptions in the mechanism:

- The operator is trustworthy and will not disclose the sensitive information of the consumers.
- The communication network between participators is kept connective.

In the following, we will illustrate the payment mechanism in detail: the architecture of the payment mechanism is described in section one; the interactions between participants are illustrated in section two.

A. Architecture of payment system

The participators in our payment system include:

consumers, merchants, the operator, and banks.

Table 1. Abbreviations of the data used in the proposed mobile payment system

Abbreviation	Description
$PhoneNo$	The consumer's phone number
BK_R	The bank's private key
BK_U	The bank's public key
OK_R	The operator's private key
OK_U	The operator's public key
$Passwd_{Trans}$	The transaction password which is only known by the consumer and the operator.
$Passwd_{Acct}$	The account password which is only known by the consumer and the bank.
$RandNo$	A random number.
$TransNo$	The transaction number only created legally by the consumer.
$Price$	The total price of the goods.
$SerialNo$	A serial number generated by the merchant.
$Date-Time$	The date and time of the transaction.
$TransData$	The transaction data summarized by the merchant.
$Digest$	The message digest created by one way hash function. The inputs of the hash function are $TransData$ and $Passwd_{Acct}$.
$TransRe$	The transaction receipt.
$Account_C$	The financial account of the consumer.
$Account_M$	The financial account of the merchant.
$Certificate_M$	The certificate of the merchant.
ID_O	The identity of the operator.
$Record$	The record of transferring accounts.
$PaymentRe$	The payment receipt.

● **Consumer:** The consumers can purchase the merchandise with cell phone at a store or website. The operator's public key is stored in the SIM card and used to generate the transaction numbers. The consumers can pay for the purchasing by using the transaction number.

● **Merchant:** The merchants provide goods to consumers. They might be real store or the web store. In the process of transaction, the merchants are responsible for summarizing and transferring the transaction data to the operator.

● **Operator:** The telecommunication operator plays an important role in the payment system. After receiving the transaction data from the merchants, the operator has

to confirm this transaction with the consumer using USSD (Unstructured supplementary service data) messages. The operator has asymmetric keys for data encryption, includes the public keys of all cooperative bank. In the proposed payment mechanism, the operator is assumed to be trustworthy. The operator has to check whether if the consumer is a legal subscriber of the payment service.

● **Bank:** The bank is responsible for settlement of accounts and the verification of consumers and merchants. After the settlement, the bank will transfer the receipts to consumer and merchant.

The detail of our payment mechanism is illustrated in next paragraphs, and the abbreviations of the relevant data used in the payment system are shown in Table 1.

B. Interactions between the participants

After the introduction of the participants, we now describe the interactions between the participants of the payment mechanism. There are three phases in our payment scheme: initiation phase, transaction phase, and settlement phase. We demonstrate each phase from the views of the participants.

1) **Initiation phase.** This phase includes the requirements and the preparations of each participant before the payment mechanism performs. Following, we will illustrate the initiation phase from aspects of each participant.

● **Consumer:** First, the consumer should have the mobile device, such as cell phone or PDA which the telecommunication module is embedded in. The mobile device must have the capability of data storage and cryptographic computing. In addition, the mobile device can also adopt the technology of short-distance wireless transmission to facilitate the procedure of mobile payment. The consumer needs to apply for the mobile payment service and transfer his financial account ($Acct_C$) to the operator. Then, the operator issues a personal transaction password ($Passwd_{Trans}$) and the public key of the operator (OK_U) to the consumer and stores these sensitive data in the SIM card of the cell phone.

In order to reduce the waiting time of payment, the consumer could generate the transaction number ($TransNo$) in advance before going shopping. The transaction number is generated by using the operator's public key to encrypt the consumer's phone number ($PhoneNo$), transaction password, and a random number ($RandNo$). The random number is generated by the cell phone and used to make the transaction number dynamic. After the generation of the transaction number, the customer can start to use the mobile payment service.

● **Merchant:** What ever real or virtual store the merchant is, it must have the capability of summarize the

transaction information. The merchant can communicate with the operator or the bank through the Internet. The real store needs a printer to print out the transaction receipt (*TransRe*). The web store can show the transaction receipt on the browser for the consumer to print it out. Besides, the real store can also facilitate the mobile payment by adopting the short-distance wireless transmission device.

For the security concern, the merchant need to apply for a digital certificate and download the certificate of the operator issued by the trusted certificate authority (CA). In the payment process, the merchant uses the public key of the operator to encrypt the transaction data.

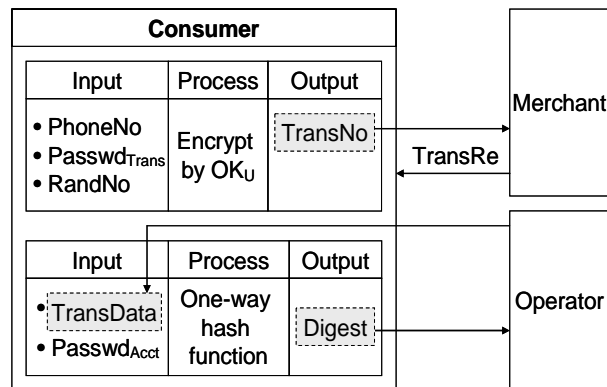


Fig. 2 Transaction phase of the consumer

● **Operator:** As for the operator, they have to maintain additional data in the database, such as the transaction passwords and the identities of the consumers' banks. After the customer applies for the mobile payment service, the operator will store the consumer's sensitive data in the secure database. The relation between the sensitive data and the corresponding consumer's phone number are protected by the operator. The operator also applies for its digital certificate and downloads all cooperative banks' certificates from CA.

● **Bank:** The bank also has to store additional data in the database, such as the account password (*Passwd_{Acct}*) of the consumer which is different from the password of the cash card. Besides, the bank needs to maintain the transaction record for future inquiries. The same with the operator, the bank need to apply for its certificate, too.

2) Transaction phase. This phase describes the data transmission and processing of all participators during the payment process. We focus on the consumer, the merchant, and the operator.

● **Consumer:** To make the payment, the consumer transfers the transaction number and the identity of the operator (*ID_O*) to the merchant. The transaction number is a ciphertext encrypted by using the public key of the operator. As mentioned in the initiation phase, several transaction numbers could be generated before the

consumer goes shopping. After the merchant summarizes the transaction information, the consumer receives a transaction receipt as an evidence of this transaction from the merchant. The transaction receipt includes all transaction details, such as the product name, unit price of the product, and so on.

Then, the consumer has to wait for the USSD message from the operator to confirm the transaction. If the transaction information is correct, the consumer has to input the account password (*Passwd_{Acct}*) as a confirmation of his identification. The cell phone will hash the transaction data and the account password by a hash function while the account password is valid. After the hash function being performed, it will create a message digest (*Digest*). Finally, the consumer transmits the message digest back to the operator to finish the transaction confirmation as shown in Fig. 2.

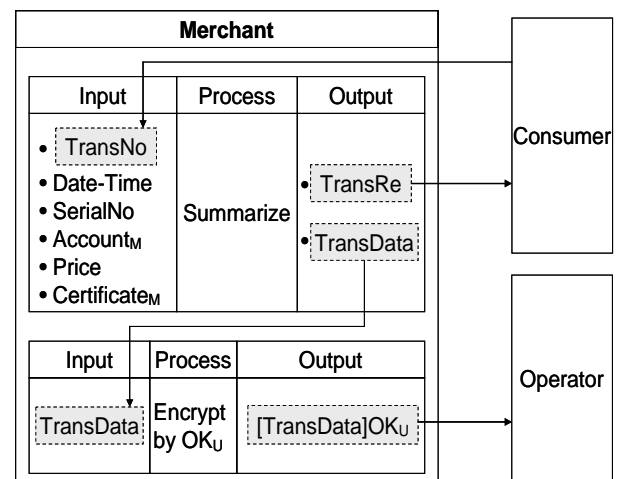


Fig.3 Transaction phase of the merchant

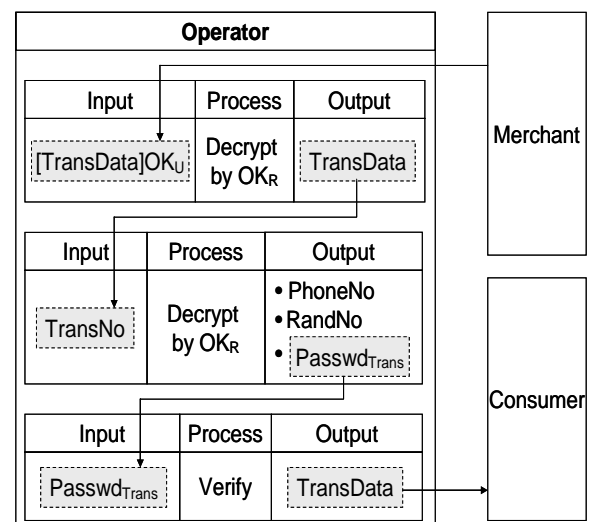


Fig. 4 Transaction phase of the operator

● **Merchant:** The merchant summarizes the required information into the transaction data (*TransData*), and encrypts the transaction data by using the operator's public key. Then, the merchant prints out the transaction receipt to the consumer as a verification of this transaction. All details about this transaction such as the item name and unit price are included in this receipt. The merchant transmits the transaction data to the operator according to the ID_O of the consumer for further confirmation. As shown in Fig. 3, the transaction data transferred includes the relative information except the details of the goods in order to ensure the transaction privacy of the consumer.

● **Operator:** The operator takes charge of the verification of the consumer and the transaction. After the operator receives the transaction data from the merchant, it decrypts the transaction data with its private key (OK_R) to get the transaction number. The operator further decrypts the transaction number and verifies the consumer's transaction password. If no error occurs in the verification, the operator will transfer the transaction data to the consumer through USSD connection for further check and waits for the consumer's response as depicted in fig. 4.

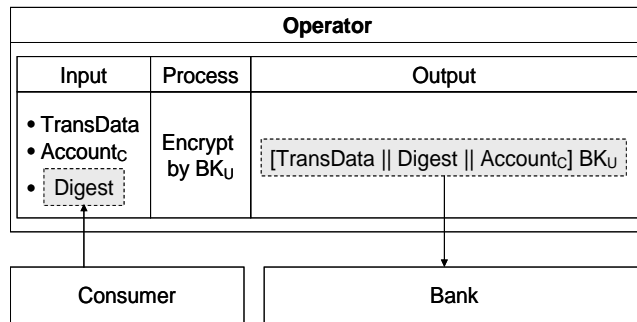


Fig. 5 Transaction phase of the operator (cont.)

Then, the operator will receive the message digest from the consumer if the transaction data is correct. The operator encrypts the transaction data, the message digest, and the consumer's bank account ($Account_C$) with the bank's public key (BK_U) and transfers these data to the cooperative bank for account settlement as shown in Fig 5.

3) Settlement phase. The settlement phase describes the verification and account settlement performed by the bank. When the bank receives the encrypted data from the operator, it uses its private key (BK_R) to decrypt the ciphertext. The bank can find the account password of the consumer by the corresponding financial account. Then the bank calculates the hash function over the concatenation of the transaction data and the account password of the consumer. If the comparison between the output of the hash function and the message digest from the operator is the same, the bank will further check the consumer's credit line and complete account settlement.

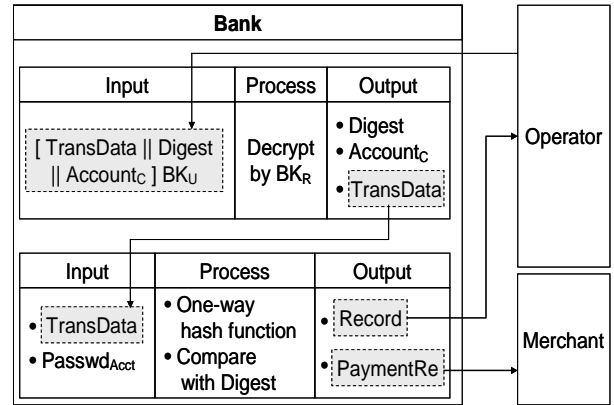


Fig. 6 Settlement phase of the bank

After settling account, the bank sums up the transaction and transfer the payment receipt to the merchant. The bank also needs to transmit the transaction record to the operator for avoiding the possible dispute. Then the merchant prints the payment receipt to the consumer, as shown in Fig. 6. Every transaction has to go through the transaction phase and settlement phase.

C. Overview of the payment process

In this section, we go into detail about the payment process of our scheme. Some notation should be explained at first. $X \rightarrow Y : Z$ denotes that a sender X sends a message or data Z to the receiver Y , $h(\)$ denotes a one way hash function, $M || N$ denotes a concatenation of data M and N , and $[I]J$ denotes a message I encrypted by key J . In our payment scheme, the payment process includes seven steps. The transaction steps are as follows:

- Step 1) Consumer \rightarrow Merchant : *TransNo*, ID_O
- Step 2) Merchant \rightarrow Consumer : *TransRe*
Merchant \rightarrow Operator : $[TransData] OK_U$
- Step 3) Operator \rightarrow Consumer : *TransData*
- Step 4) Consumer \rightarrow Operator : *Digest*
- Step 5) Operator \rightarrow Bank :
 $[TransData || Digest || Account_C] BK_U$
- Step 6) Bank \rightarrow Merchant : *PaymentRe*
Bank \rightarrow Operator : *Record*
- Step 7) Merchant \rightarrow Consumer : *PaymentRe*

In step 1, when the consumer shops at a real store or a web store, he has to transfer the *TransNo* to the merchant. The *TransNo* is generated as follows:

$$TransNo = [PhoneNo || Passwd_{Trans} || RandNo] OK_U \quad (1)$$

The consumer can generate several transaction numbers and store them in the cell phone to facilitate the payment.

In step 2, after merchant received the *TransNo*, it

summarizes the transaction information into *TransData*.

$$\begin{aligned} TransData = & TransNo \parallel Date-Time \parallel SerialNo \parallel \\ & Account_M \parallel Price \parallel Certificate_M \end{aligned} \quad (2)$$

Then, the merchant prints out the transaction receipt to the consumer. The merchant also encrypts the *TransData* with OK_U and transmits it to the operator according to the ID_O received from consumer.

In step 3, the operator decrypts the data received from the merchant and gets the *TransNo*. The operator further decrypts the *TransNo* and gets the $Passwd_{Trans}$ of the consumer. The operator will check if the transaction password is correct. If the $Passwd_{Trans}$ is valid, the operator will transmit the *TransData* to the consumer through USSD connection.

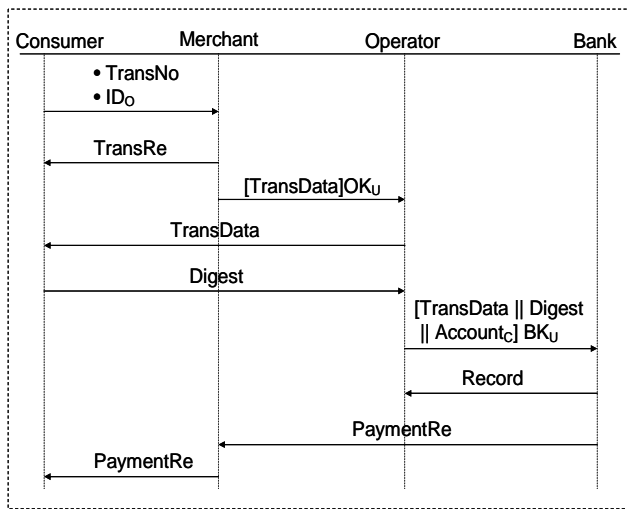


Fig. 7 Data flow of transaction procedure

In step 4, the consumer checks the *TransData* received from the operator. If this transaction is confirmed, the consumer is asked to enter the $Passwd_{Acct}$ for a hash function:

$$Digest = h(TransData \parallel Passwd_{Acct}) \quad (3)$$

The cell phone will create a message digest and send it back to the operator. But if the consumer rejects the payment or enters the wrong $Passwd_{Acct}$ three times, the operator will transfer a message to inform the merchant about the breach of the transaction.

In step 5, the operator summarizes the relative transaction information and encrypts them with the BK_U . The operator transmits the encrypted data to the bank through wired network.

In step 6, the bank decrypts the data received from the operator with its BK_R . The bank will find the corresponding $Passwd_{Acct}$ of the consumer according to the $Account_C$ and check if the $Passwd_{Acct}$ is valid. Then, the bank calculates the same hash function and compares it with the *Digest* as

follows:

$$\text{Check if } h(TransData \parallel Passwd_{Acct}) = Digest \quad (4)$$

If the result of the hash function is the same with *Digest*, the bank will settle accounts and transmit the payment receipt to the merchant. At the same time, the bank also transmits the transferring record to the operator and sends the short message to notify the consumer. In step 7, the merchant prints out the payment receipt to the consumer. The web store can show the payment receipt on the web browser, and the consumer can print it by himself.

Above, the payment mechanism has been demonstrated in detail. All data transferred between the participants are shown in Fig. 7. According to the security criteria, we evaluate our payment mechanism from different points of view in section four.

IV. Analysis of Security and Discussion

When we talk about security and related subject, some security requirements should be achieved, as mentioned in [10]-[13]. In this section, we evaluate our payment mechanism from two aspects: the aspect of the security criteria and the aspect of the attacker's role.

A. Evaluate from the aspect of security criteria

1) Confidentiality. We first consider the aspect of data storage; the sensitive data of transaction and the encryption keys are stored in the SIM card which is a tamper-resist device. And if the cell phone was lost or stolen by others, the verification of the PIN and the $Passwd_{Acct}$ prevent the cell phone from misusing by someone else. It is proven that even the SIM of legal user is cloned, the fraudulent usage can be detected quickly [14].

As for data transmission, the data between the merchant and the operator or between the operator and the bank can be transferred through the wired network such as ADSL, which use SSL transaction protocol to ensure the security of data. SSL is also a practical solution for ensuring end-to-end security of wireless Internet transactions even within today's technological constraints [15]. In our payment scheme, the data transferred in the wired network is protected by the public-key based algorithm which can prevent the confidential attack effectively [16]. For example, the RSA public-key encryption algorithm is used for the protection between the bank and the operator, and illustrated as follows:

The Operator has the public key of the bank: $BK_U = \{e, n\}$ and the bank has the corresponding private key: $BK_R = \{d, n\}$ (n is calculated from $p \cdot q$, p and q are both prime, e is a selected integer and the greatest common divisor of e and $(p-1)(q-1)$ is 1, d is calculated from $d = e^{-1} \bmod ((p-1)(q-1))$). Let M be the plaintext and C be the ciphertext. The operator encrypts the secret transaction information with BK_U :

$$\text{Operator : } C = M^e \pmod{n}, M < n \quad (5)$$

Only one that has corresponding private key can decrypt the ciphertext and gets the secret information (i.e. in the example above, only legal bank that has the private key BK_R can decrypt the ciphertext).

$$\text{Bank : } M = C^d \pmod{n} = M^{ed} \pmod{n} \quad (6)$$

It is infeasible to determine d given e and n . Currently, a 1024-bit key size is considered strong enough for virtually all applications. Besides, the secure connection of USSD between the operator and the consumer is provided by the signal protection mechanisms of GSM/UMTS [17].

Table 2. Key sizes for equivalent security levels (bits).

Symmetric	ECC	RSA/DH/DSA
80	163	1024
128	283	3072
192	409	7680
256	571	15,360

2) Privacy. The transaction privacy of the consumer depends on the *TransNo* — it is very difficult for the merchant to get personal information of the consumer because it has no corresponding key to decrypt the *TransNo*. The *TransNo* is protected by the encryption of the asymmetric cryptography which is hard to be broken [18]. Some cryptographic algorithms which are suitable for the wireless communication were proposed, such as Elliptic Curve cryptography (ECC) [19]. A 571-bit ECC is currently equivalent in security to 15,360-bit RSA, as shown in Table 2. The smaller key size for equivalent security levels accounts for the performance advantages to be obtained from substituting ECC for RSA, especially in wireless environment. The Elliptic Curve cryptography is derived from the equation of elliptic curve:

$$y^2 = x^3 + ax + b \quad (7)$$

where a and b are elements of a finite field with p^n elements, p is a prime greater than 3. The detail about Elliptic Curve cryptography can be found in the reference [20].

Under the proposed mechanism, the merchant is unable to collect the purchasing habits of a consumer because of the secure protections of the asymmetric cryptography suitable for small hardware, such as ECC.

In the aspect of the operator and bank, only total amount of the price is in the transaction data. So, even though the operator and the bank knew well about the real identity of the consumers, they cannot know what merchandise the consumer has purchased (as shown in Fig. 4 and Fig. 6). In our payment mechanism, the consumers have the overall privacy.

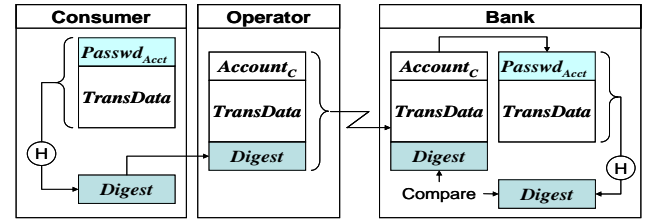


Fig. 8 Authentication using a one-way hash function

3) Authentication. The consumer is authenticated three times in our payment mechanism:

First, the cell phone verifies the PIN of the consumer.

- Second, the operator verifies the $Passwd_{Trans}$ after decrypting the *TransNo*.
- Third, the bank verifies the $Passwd_{Acct}$ of the consumer through message authentication using a one-way hash function depicted in Fig. 8.

With those three authentications, the risk of counterfeit is reduced to the minimum.

As for the merchant, the bank authenticates the merchant by verifying its certificate. The certificate of the merchant is issued from the trusted third party which could be the governmental institution, so it can restrain the malicious merchant. Sulin proposed a new design of trusted third party which is built on the current models of CAs but has enriched functionality [21]. They proposed a Trusted Third Party System Strategy (TTPSS). TTPSS is a sequential equilibrium strategy of the trusted third party system stage game. The TTP model can be very effective in promoting small business online transactions and consumer-to-consumer transactions. This authentication model could also be adopted in our payment scheme to expand the participants and to ensure the transaction effectiveness.

4) Non-repudiation. After the consumer confirms the transaction, he has to enter the $Passwd_{Acct}$ for the calculation of message digest. Then, the bank authenticates the consumer by verifying the message digest. Only the legal consumer and the bank can calculate the same *Digest* because the $Passwd_{Acct}$ is only known by them. The transaction is confirmed if the *Digest* was correctly verified, and the consumer cannot deny the transaction. The bank transmits the payment receipt to merchant after account settlement, so the merchant can avoid the risk of consumer's bad debit.

5) Integrity. After the merchant summarizes the *TransData*, it prints out the *TransRe* to the consumer. The bank transfers a *PaymentRe* to the merchant after the account settlement (as shown in Fig. 2). Then the merchant prints the *PaymentRe* to the consumer. These two receipts can be combined through the *SerialNo* of the transaction. The consumer can ensure the integrity of the transaction by comparing these two receipts.

6) Other Discussion. Besides the security criteria mentioned

above, our payment mechanism is also feasible. The main reason is that it will not take great cost to the participator to adopt the payment mechanism into his business model. The consumer can generate the *TransNo* before go shopping. And the computational load can be reduced in the payment process because only hash function is performed by the cell phone.

B. Evaluation from the aspect of attacker's role

There are four participators in our payment scheme and any of them might be malicious except the operator. The operator is assumed to be trustworthy in our mechanism. We will discuss the possible attacks of the malicious participators and how to prevent them in our payment scheme in this section.

1) Malicious merchant—deny the transaction. In our payment scheme, the merchant need to deliver the goods to the consumer after receiving the *PaymentRe*. The malicious merchant might refuse to deliver the goods and conceal the *PaymentRe* from the bank. But while the bank completes the account settlement, it will not only transfer the *PaymentRe* to the merchant but also send the consumer a short message which is used to notify the consumer of the completion of the payment. The bank also needs to transmit the transaction record to the operator for future inquiry. Therefore, after the consumer received the short message, the truth of the payment can be proved. The consumer can demonstrate the evidence of the payment from the transaction record preserved in the operator and bank.

2) Malicious merchant—steal the *TransNo* from the consumer. The malicious merchant might try to get the legal *TransNo* of the consumer by hook or by crook. If the merchant uses the *TransNo* which is stolen from the consumer to forge a transaction, the consumer will be aware of the misuse of the *TransNo*. In the step 3 of our payment process, when the operator confirms the transaction with the consumer through USSD connection, the consumer can refuse the transaction. Moreover, once the consumer found the misappropriation of the *TransNo*, he (she) can inform the operator to trace the malicious merchant through the digital certificate of the merchant.

3) Malicious consumer—fabricate the *TransNo*. The malicious consumer might try to forge the *TransNo* of another legal consumer to make transaction. They might create a *TransNo* by getting wise to another consumer's *PhoneNo*. But the fake *TransNo* will soon be revealed because the malicious consumer cannot get the exact *Passwd_{Trans}* of the corresponding *PhoneNo*. Even if the malicious consumer is lucky enough to guess the right *Passwd_{Trans}*, he will not pass the transaction confirmation in the step 3 and the verification of *Passwd_{Acct}* in the step 4 of our payment scheme. The probability of guessing right the *Passwd_{Trans}* and the *Passwd_{Acct}* at the same time is very little.

4) Malicious bank—disclose the *Passwd_{Acct}*. Generally, the bank is trusty. However, the employee of the bank might benefit from disclosing the important consumer information. For example, the employee might eavesdrop to the *Passwd_{Acct}* of the consumer and sell it to the evildoer. But our payment mechanism is secure enough to against the attack which the *Passwd_{Acct}* is misused. As for the consumer, the exact *Passwd_{Trans}* and *Passwd_{Acct}* are needed in every transaction. The transaction can not be complete without one of these two passwords. Besides, the transaction confirmation by the operator can prevent the transaction relative passwords are misused by malicious consumer. As for the merchant, it delivers the good to the consumer only when the *PaymentRe* is received and no cancel message is received from the operator. The consumer authentication and the transaction confirmation executed by the operator can prevent the consumer and the merchant from losing on illegal transaction.

5) Malicious merchant and bank—tamper the *TransData*. The malicious merchant might collude with the employee of the bank, and devise a way to tamper the *TransData* to make profit illegally. For example, the employee of the bank might tamper the *Price* of the transaction in our payment process. Because the bank knows the *Passwd_{Acct}* of the consumer, it can forge the original *Digest* and confirm the transaction. The malicious merchant might use the fake *PaymentRe* to take the place of the real one. But while the bank transfers the fake price into the account of malicious merchant, the *Record* transmitted to the operator in the step 6 of the payment process will reveal the illegal activity. The *Record* is generated through the secure mechanism of the bank, and it is not easy to be tampered.

6) Malicious consumer and bank—forge the *PaymentRe*. The malicious consumer may cooperate with the employee of the bank. The malicious consumer might pretend to purchase goods in the merchant and refuse to pay for the transaction actually. Then, the employee of the bank may try to forge a *PaymentRe* according to the confirmation data transmitted from the operator to the consumer. But in our payment mechanism, if the legal consumer rejects the payment, the operator will notify the merchant that the payment is cancelled by the consumer. So, even if the merchant received the fake *PaymentRe*, it will have the sufficient reason to deny the transaction.

After the discussion and evaluation, our payment mechanism can ensure high security for all participators.

7) Malicious consumer and merchant—repudiate the transaction. The malicious consumer might collaborate with malicious merchant to make the transaction inconsistent, and request for the compensation to the bank. But the bank proceeds to transfer account only after the identifications of the consumer and the merchant are

authenticated and the transaction is confirmed by the legal consumer. Therefore, the merchant and the consumer cannot deny the transaction and have no reason to ask the bank for compensation.

V. Conclusion

The development of the Internet, handset devices, and telecommunication technologies are changing the way of our life extremely, especially in commerce. Lots of novel business models emerge rapidly. However, the most important and insecure stage in the transaction is payment. Without an appropriate payment mechanism, any business model will be hardly put into practice. Therefore, we have an urgent need for designing a securer and more convenient payment mechanism.

The payment mechanism we proposed adopts the cell phone to be the payment tool. By making use of the transaction number, our payment mechanism provides many advantages:

- **Security:** Our payment scheme meets security criteria which includes confidentiality, authentication, integrity, and non-repudiation during the payment process. Besides, the risk can be minimized when the consumer loses the cell phone or the cell phone is forged because our method provides multiple authentications.
- **Full transaction privacy:** The merchant cannot get the real identification of the consumer because the transaction number is dynamically changed and protected by the asymmetric encryption. Besides, the operator and the bank cannot acquire the detail of the merchandise purchased by the consumer except the total amount of price. Therefore, no one except the consumer can gather the transaction habit.
- **Convenience:** The time of the payment can be shortened because the time-consuming operation of the encrypt algorithm can be done in the initiation phase. In other words, the transaction number can be generated and stored in the cell phone before the consumer goes shopping.
- **Low computational load of the mobile phone:** The operation of the consumer in the transaction phase can be only a one-way hash function. The speed of one-way hash function is approximately 100 times faster than that of the encryption/decryption of the secret-key system and the speed of the encryption/decryption of the secret-key system is about 100 times faster than that of the signature/verification of the public key system [13].
- **Feasibility:** In addition, the participators can adopt our payment scheme into their business model without additional cost of hardware. And it is implemented based on the existing network environment.

Besides the advantages mentioned above, we also evaluate the payment scheme from the aspect of security criteria and the attacker's role in detail. Our payment scheme has been proved that it can effectively prevent any

participator's malicious attack.

Our payment mechanism is very suitable for the payment from medium to large amounts of money because it has overall protection of security and full transaction privacy. And it can be more flexible if we integrate it with other payment systems, such as micro-payment system, e-cash and so on. Our mobile payment scheme has made great progress toward a more omnibus and secure payment scheme for the new era.

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The Influence of User Characteristics and Experience on Ethical Opinions of Internet Marketing

Sally Rao

School of Commerce

The University of Adelaide

233 North Terrace, Adelaide, SA 5000

Ph: +61 8 8303 4237

Fax: +61 8 8303 4368

e-mail: sally.rao@adelaide.edu.au

Extended Abstract

As many other areas of business, internet marketing has been under attack by social commentators and other consumer or general public organisations for alleged unethical practices. As sophistication of marketing tools and techniques improve and as the impact of the internet on society grows, ethical considerations must be addressed if public trust in the profession is to be secured and maintained.

While e-marketing is subject to the same general criticism as marketing from the general media, mainly about issues such as consumers' right, misleading information or freedom of choice, its specific characteristics make it a fertile ground for other, more specific ethical dilemmas than those previously experienced or identified by marketers. It is therefore useful, when examining the generic portfolio of marketing activities, to identify the specific nature of some e-marketing decisions, in order to identify where a specific ethical dilemma may arise. In other words, although the internet technology may not have generated any new or unique ethical issues, many of the controversies associated with this technology might warrant special considerations from an ethical perspective. Further, consumers' personal characteristics such as the individual's level of moral development and personality and cultural environment may impact also on consumer choices in a situation involving ethical issues.

Given the exploratory nature of the study, a convenience sample of avid Internet users was selected and asked to rate and rank ethical dilemmas. 41 ethical issues were encapsulated in the short descriptive scenarios provided as examples in the previous section and respondents were asked to rate these issues in terms of the ethicality of the situation and the importance of this issue when considering an internet site or an etailer/service provider. Although the inclusion of the examples (e.g. McDonald's) may have biased the sample by framing the respondents' perceptions of the issues, it was considered important as a means of focusing participants' responses. The majority of respondents (76%) were between the age of 19 and 22, with

even split between males and females. In terms of internet usage activities, the vast majority of respondents (64%) used the internet on a daily basis with another 30% using the internet 2 to 6 times a week. Thirty eight percent of respondents spent 1-2 hours each time they access the internet, followed by a 31% spending less an hour on the internet each time they access the internet. Many respondents (59%) had purchased goods on the internet while a staggering 82.6% used an online service. There was no significant difference between genders in terms of internet use.

The results showed that five out of the top ten issues are related to e-marketing practices targeting children, indicating that using the internet in targeting children is a serious consumer concern. Surprisingly, the fourth issue involves one of the consumer ethical issues – 81% of respondents consider purchasing prescription-only drugs online without a valid prescription unethical. The fifth issue relates to the content of advertising messages. A little over 80% (80.5%) of the respondents agreed or strongly agreed that using sex, nudity and racist languages in online advertising messages was unethical. Respondents also seemed to be concerned about online market research activities. Consistent with findings from previous research, about 80 per cent of internet consumers considered the intrusion privacy through data collection and spam is very unethical or unethical.

Further, two primary antecedents of ethical opinions can be identified from data collected: (1) user characteristics such as gender, nationality, and age; (2) user experience in terms of length and frequency of internet use, amount spent in online purchase and activities on the internet. For example, the Spearman's rank order correlation tests show that the positive association between frequency of internet use and opinions on using incentives on websites targeted at children, selling drugs online, grey importing and realtime pricing is significantly, but not very strong. This suggest that as internet use become more prevalent, consumers may become desensitised to some of the ethical issues that are prickly currently. It is important to note, however, that this is not intended to be an exhaustive list of antecedents to ethical opinions. Rather, these are variables that can be identified from existing research and are considered important for ethical opinions. More antecedents may emerge in the future as our knowledge of consumers' online interaction deepens.

In brief, this paper offers a critical examination and analysis of key ethical issues arising in the planning and execution of internet marketing practice. It provides a critical reflection on ethical implications of specific e-marketing strategies and practices and discusses the influence of user characteristics and experience on their opinions of ethical issues and consequences of those strategies and practices that marketing managers may consider in their decision making.

It is important to note the limitations of our study and, more particularly, the convenience nature of our sample. Further replicate research could be conducted using a sample with different demographic characteristics. Despite these limitations, our study showed that internet users are aware and concerned about ethical issues about e-marketing. Marketing professionals, therefore, should not ignore these concerns and they should examine their practices in the light of their consumers' ethical sensibility. Similar research with respect to knowledge, awareness and use of privacy protection strategies relevant to e-commerce is needed. For example, research should examine whether consumers are more aware of privacy protection strategies related to internet use. Further, will these ethical issues disappear as time goes on and consumer gain more internet experience? Longitudinal studies of consumers ethical opinions on internet marketing practices is warranted as e-business applications develop.

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Determinants of Online Auction Participation: How Much Do Web Knowledge and Risk Perception Matter?

Sophia Wang¹, Jenny Tian²

1 National Dong Hwa University, Taiwan

2 University of Southern California, USA

Abstract: This study extends the research on online consumer behavior by examining the effect of Web knowledge and risk perception on individual attitude towards and intention to participate in online auction. The survey findings show that individuals with high Web knowledge tend to form positive attitudes towards online auction. By contrast, individuals who have heightened concerns about Internet privacy and security show less favorable attitudes towards online auction. Consistent with the attitude-intention model, attitude appears to mediate the effect of know and risk perception on intention. Research and practical implications of these results are discussed.

Keywords: Security, trust, privacy and reputation in e-business; Online auction; Online consumer behavior

I. Introduction

Online auction has become the newest trend of e-commerce. Some researchers argue that online auction epitomizes “the democratization of the Internet” because, potentially, anyone with an Internet connection can become a merchant [1]. The implications of Internet and database technologies for auction design have been widely discussed in the literature [2]. Many previous studies have also examined overt bidding behaviors of online auction participants, typically based on archival data collected from various auction sites [3]. Despite the increasing research attention, it remains unclear why some Internet users are more likely to participate in online auctions than others. Although much research has been done to classify observable bidding behaviors, we know little about the unobservable cognitive and psychological forces that drive these bidding actions.

Drawing upon the research on technology adoption and online consumer behavior, the present study is intended to identify the determinants of an individual’s attitude towards and intention to participate in online auction. Online bidding is conceptualized as a task involving high information processing demand and high outcome uncertainty. Therefore, we focus on two categories of determinants: knowledge and risk perception. A basic argument is that individuals with high Web knowledge and low perceived risk of the Internet tend to develop positive attitudes towards online auction. With a few exceptions [4], the effect of knowledge and risk perception on attitude and behavioral intention have

typically been examined separately in previous studies. This paper integrates the research on individual knowledge structure and risk perception (and its flip side – trust belief) into the belief-attitude-intention framework of human behavior [5].

II. Hypotheses

II.1 Web Knowledge

Web knowledge, or the level of understanding of the Internet as an information and communication mechanism, can be gained via direct experience of using the internet and/or from secondary sources (e.g., technical manuals). We measure Web knowledge along two dimensions: skill and experience. Web skills refer to an individual’s perception of how skilled he or she is at using the Internet. Measured as subjective knowledge, Web skills are similar to computer self-efficacy, defined as “an individual judgment of one’s capability to use a computer” [6]. Prior research has shown that computer self-efficacy reduces an individual’s computer anxiety and leads to a favorable attitude towards new technologies [7]. Similarly, in the context of online auction, individuals with high levels of Web skills may feel less anxious when viewing and searching the vast amounts of information about auction products, prices, shipping arrangements, payment methods, buyer and sellers, and so on.

The second dimension of Web knowledge is related to one’s direct experience of using the Internet, particularly for the purpose of shopping. The amount of purchase experience has often been used as a measure of consumer knowledge [8]. The attitude-intention model suggests that the more positive a person’s past experience about an object, the more positive beliefs he or she will hold about it. Familiarity based on previous experience helps reduce uncertainty and increase perceived behavioral control. Online auction is similar to online shopping in the sense that both involve economic transactions and financial payments. More important, both are particularly important predictor of attitude towards online auction. The more favorable online shopping experience that an individual has accumulated over time, the more likely he or she is to develop a positive attitude towards a related transactional mechanism – online auction. These arguments lead to the following hypotheses:

H1: Web skills are positively related to attitude towards online auction.

H2: Favorable Web experience is positively related to attitude towards online auction.

II. 2 Risk Perception

Online auction is not risk-free. In a virtual market of unseen participants and products, buyers and sellers are faced with the risk caused by information asymmetry. Since potential buyers have no physical access to the product in question, sellers can easily misrepresent the condition or the quality of their products. Auction participants also face the risk caused by opportunism. For example, buyers or sellers may decide not to abide by the contract. To make things worse, the cost of enforcing a contract is high relative to the value of the auction product / service in many cases, resulting in an absence of legal enforcement in the online auction community. In general, transactions conducted on the Internet are viewed as riskier than offline transactions. However, individuals hold different risk perceptions regarding the Internet and what matters for attitude formation is the risk as *perceived* by potential auction participants. We examine perceived risk in two ways. First, we argue that disposition to trust, defined as a general inclination to display faith in humanity and to adopt a trusting stance toward others [11], should be associated with a positive attitude towards online auction. Individuals with high levels of trust propensity tend to believe that people in general are trustworthy. This belief is neither situation-specific nor based upon knowledge of a specific trusted party. Therefore, disposition to trust may have greater influence over attitude and behavioral intention in situations where the transactional parties are unfamiliar with each other. Previous studies also establish that trust reduces risk perception [12].

We also examine situation-specific risk perception, that is, an individual's concern towards the Internet's reliability as a transactional medium. Two types of risk are predominant in the online environment -- perceived risk associated with privacy and security [13]. Various surveys have shown that Internet users are increasingly concerned about the unauthorized collection, improper storage, and inappropriate use of their personal data by online marketers. Closed related to this privacy concern is the concern about the security of transmitting financial information (e.g., credit card number). The anonymity on the Internet and the ambiguity of the online environment makes it difficult for consumers to distinguish trustworthy transaction parties from less trustworthy ones. Therefore, they may transfer their privacy and security concerns to the Internet -- the medium itself [14]. Individuals with high levels of perceived Web risk will then tend to avoid online auctions. These arguments lead to the following hypotheses:

H3: Disposition to trust is positively related to attitude towards online auction.

H4: Perceived Web risk is negatively related to attitude towards online auction.

II. 3 Attitude and Intention

The belief-attitude-intention framework views participation in online auction as a consciously intended behavior. This

framework suggests that an individual's performance of a specific behavior is determined by his or her intention to perform that behavior. Behavioral intention, in turn, is determined by attitude. The positive relationship between attitude and behavioral intention has been examined in various empirical contexts ranging from acceptance of Internet-based self services [13] to online shopping [15]. Consistent with the attitudinal model, this paper proposes that attitude should mediate the effects of Web knowledge and risk perception on intention to participate in online auction.

H5: Attitude mediates the relationships between Web knowledge and risk perception and intention to participate in online auction.

III. Methods and Results

Survey data were collected from a sample of 126 undergraduate students majoring in business administration and accounting. All theoretical constructs were measured using established scales. The exploratory factor analysis (EFA) shows that all items converge to form distinct factors and there is no cross-loading of items. The Cronbach's alpha coefficients for the measurement scales all exceed .70. These results provide further evidence for the validity and reliability of the measurement model.

Descriptive statistics are shown in Table 1. OLS regression analysis was conducted to test the hypotheses. The results are shown in Table 2. In Model 1, the dependent variable (DV) -- attitude was regressed on four independent variables (IVs). Consistent with H1 and H2, Web skills and favorable Web experience are both positively related to attitude towards online auction. Empirical support is also found for perceived Web risk (H4). However, the hypothesis that disposition to trust and attitude are positively related (H3) is not supported. We followed the four-step approach suggested by Baron and Kenny [16] to test the mediating effect of attitude on intention (H5). The regression results for Model 2 are similar to those for Model 1, indicating that three IVs (i.e., Web skills, favorable Web experience, and perceived Web risk) are significantly related to intention to participate in online auction. Model 3 shows that attitude has a significant and positive effect on intention. Finally, the full model (Model 4) shows that, except for attitude, all the other four IVs are no longer significantly related to behavioral intention. These results are consistent with a full mediation model, as suggested in H5.

IV. Discussion

In this study, we investigated the effect of Web knowledge and risk perception on attitude formation in the context of e-auction. We found that high Web knowledge positively affect an individual's attitude towards online auction that, in turn, translates into strong intention to participate in online

Table 1 Mean, Standard Deviation and Correlation

		Mean	s.d.	1	2	3	4	5	6	7
1.	Gender	.45	.50							
2.	Age	19.45	1.12	.06						
3.	Disposition to trust	4.56	1.02	-.11	-.04					
4.	Web skills	4.48	1.03	.11	.18	.09				
5.	Positive Web experience	4.72	1.24	.07	.10	.11	.32***			
6.	Perceived Web risk	4.71	1.23	.11	.12	-.28**	-.06	-	.30***	
7.	Attitude	4.21	1.25	.03	.01	.13	.47***	.48***	-.28**	
8.	Intention	4.53	1.48	-.08	.07	.20*	.41***	.46***	-	.75***
									.34***	

Table 2 Linear Regression Results

	Model 1 (IVs→Attitude)	Model 2 (IVs→Intention)	Model 3 (Attitude→Intention)	Model 4 (IVs Attitude→Intention) &
(Constant)	1.49 (.83)	1.68 (.98)	.91** (.31)	.56 (.77)
Gender	-.03 (.19)	-.31 (.22)	-.29 (.17)	-.28 (.17)
Disposition to trust	.02 (.09)	.11 (.11)		.09 (.08)
Web skills	.44*** (.09)	.44*** (.11)		.11 (.09)
Positive Web experience	.32*** (.08)	.36*** (.10)		.12 (.08)
Perceived Web risk	-.17* (.08)	-.24* (.10)		-.12 (.08)
Attitude			.89*** (.07)	.75*** (.08)
<i>R square</i>	.36	.35	.76	.78

auction. On the other hand, individuals who had heightened concerns about Internet privacy and security showed less favorable attitudes towards online auction. The data support the mediation model in which attitude serves as a bridge psychological mechanism that links belief and behavioral intention. Interestingly, we did not find any relationship

between disposition to trust and attitude / intention. This may be due to the multidimensional usage dimensions of the Internet. A powerful mechanism for information search, communication, and transaction, the Internet would engage users and consumers with different personality traits. It might be difficult to observe the direct effects of personality traits on specific Web behaviors [14].

This study shows that both knowledge and risk perception matter for attitude formation in the context of online auction. Theoretically, these findings call for attention to an integrative framework about consumer behavior in e-commerce transactions. Practically, auction sites and online sellers will benefit through increased understanding of how concerns about Internet privacy and security may affect a customer's response to online transactions. This study also shows the importance of increasing customers' familiarity with a specific Web site. Auction sites, online stores, and individual sellers who list their products on an auction site should focus on Web features that are easy to recall and that can create a sense of familiarity (e.g., a carefully designed "about us" section and/or timely email reminders) because customers' positive specific experiences will lead to positive general beliefs and attitudes.

Future research should explore additional aspects of Web knowledge and risk perception. Moreover, research evidence has been mixed regarding the relationship between knowledge and risk perception. While some researchers suggest that knowledge helps reduce risk perception, others argue that more experienced and knowledgeable Internet users actually are more concerned about online risks. More research is needed to clarify this issue.

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The Conceptual Design and Implementing Web Services Security Framework for Ministry of Information and Communication Technology in Thailand

Pakpoom Prechapanich *, Prasong Praneetpolgrang **, Nutsapun Paopun+

* Master of Business Administration

(Electronic Commerce) Graduate School, Sripatum University

61 Phaholyothin Rd., Jatujak 10900 Bangkok, Thailand

Email : prechapanich@gmail.com

** Master of Science

(Information Technology) Graduate School, Sripatum University

61 Phaholyothin Rd., Jatujak 10900 Bangkok, Thailand

Email : prasong@spu.ac.th

+ Master of Business Administration

(Electronic Commerce) Graduate School, Sripatum University

61 Phaholyothin Rd., Jatujak 10900 Bangkok, Thailand

Email : nutsapun@spu.ac.th

Abstract: This research aims to present a Web Services Security Framework for Ministry of Information and Communication Technology (MICT) in Thailand as referred to international standard BS7799 on information security management. With a pilot development of web services which based on e-government, the researcher used Ministry of Information and Communication Technology as a case study. In order to understand the developmental pilot, it's crucial to realize particularly in web services security and to determine proposed or existing system. Finally, it can be as standard guideline for Thai public organization for developing web services security framework.

Keywords: Web Services, Security, BS7799, ISMS.

I. Introduction

Today, Internet and information technology have played important role widely overall fields. It's obvious that related security system has been increasingly interested by public. Progressively, public affair service has been developed into e-government where major technology applied is Web Services. A medium for inter-exchanging data and services which security system is needed inevitably to protect valued data of user account. In this research, web service security framework has been devised by researchers utilizing Ministry of Information and Communication Technology in Thailand as a case study. The purpose of study is to examine and establish Web Services Security Framework for Ministry of Information and Communication Technology, and to assess security system of existing Web Services in Ministry of Information and Communication Technology under developed security framework.

The applied research as a government institution case study is based on BS7799 [8], an universally acceptable standard; data management standard for security, where its requirement covers overall performance procedures in both

data access and storage in organization. This aims to develop security framework applicable to reality performance and applied to other divisions in the same direction usefully.

Since the study is focused on management practices other than technical support. The deliverable results are technical and administrative web services security framework. The appropriation of security framework has been inspected by auditing expertises and referred to research literature in framework for web services security [4,5,6], web services security theory [1,2,3,13,14], web services standard [9,10,15] and information framework [12]. The study is designed to determine if existing and potential web services are somewhat to be have security maintained. In addition to continue development to acquire future integral information.

II. Review of Related Standard and Framework

II.1 BS7799 [8]

This British Standard has been prepared for business managers and their staff to provide a model for setting up and managing and effective Information Security Management System (ISMS). The adoption of and ISMS should be strategic decision for an organization. The design and implementation of an organization's ISMS is influenced by business needs and objectives, resulting security requirements, the processes employed and the size and structure of the organization. These and their supporting systems are expected to change over time. It is expected that simple situations require simple ISMS solutions.

This British Standard can be used by internal and external parties including certification bodies, to assess an organization's ability to meet its own requirements, as well as any customer or regulatory demands.

II.2 Associated Web Services Standards [1]

Various techniques were developed to solve the problems faced in web services regarding how to make it interoperable,

distributable, integratable, and so on. Some of these techniques were proposed by industry giants and became standards over time. We will look at a few of these standards.

XML

One of the emerging concerns of web-based programmers was how to transmit data across HTTP networks in an interoperable manner. XML emerged as an interoperable format. XML typically is stored as easily as readable text files. XML documents have a structure that can be parsed to quickly turn data into other formats, for example for database storage. Many vendors of storage products, such as database storage products, have enhanced their products to easily handle the XML formats. Standards have been developed for the structure of XML for messaging use. XML has enjoyed widespread adoption and adaptation, which quickly has made it the messaging standard.

RPC, XML-RPC, and SOAP

Remote object accessing technology began with the standard RPC calls, in which method could be invoked from one application to another remote one. The limitation of the RPC was that it work on connection-oriented, communication protocols, which cannot be used with the connectionless protocols used in the Internet.

Firewalls were another fundamental problem in the RPC systems. To use the RPC system on required protocol-specific filters with additional software, configuration, and additional management. The XML-RPC evolved in the process of solving these problems.

Another standard that emerged immediately after the XML-RPC was the SOAP. This defines the structure of message to be communicated across the Internet between a web service client and a host. SOAP emerged due to the problem of firewalls being primarily configured to access objects via HTTP. SOAP does not replace RPC, as it includes the SOAP-RPC and SOAP document styles, which is why it is the preferred HTTP-based message protocol.

WSDL

A web services is published for other to discover it and then use it. To be able to use it one needs to describe it, provide details for using it, and place it under the right category, similar to the Yellow Pages. The WSDL standards were developed to fulfill this requirement by creating a standard way of capturing the service description. In this, a service is described in terms of the operations (that is, input/output messages) and a set of interactions between a service provider and a service requestor. It describes the interface of how to interact with the service. The name of the service and a list of operations and their bindings make up the XML-based WSDL file.

From a security point of view, one should keep in mind that this is a plaintext file in ASCII, UTF-8, or some base64-encoded format.

UDDI

Web services needed a way to present a company's information in a manner that compared their features equally. Using search engines for this purpose was not the most efficient means of allowing business to interoperate with each other at a web services level, and as a result the UDDI directory of web services emerged.

The UDDI is a registry service project that provides a means for business hosting a web services to register with the worldwide registries. The project is focused on assisting business in finding each other by allowing the registration of a web services and the searching of registries to locate specific web services based on a number of criteria. The UDDI is not linked directly to any other standards initiatives or standards groups. However, it does take advantage of groups that provide standards and initiatives within the web services industry.

COBIT framework [12]

COBIT has been developed as a generally applicable and accepted standard for good Information Technology (IT) security and control practices that provides a reference framework for management, users, and IS audit, control and security practitioners.

COBIT, issued by the IT Governance Institute and now in its third edition, is increasingly internationally accepted as good practice for control over information, IT and related risks. Its guidance enables an enterprise to implement effective governance over the IT that is pervasive and intrinsic throughout the enterprise. In particular, COBIT's Management Guidelines component contains a framework responding to management's need for control and measurability of IT by providing tools to assess and measure the enterprise's IT capability for the 34 COBIT IT processes.

III. Research Design

This research has developed web services security framework. Ministry of Information and Communication Technology in Thailand was selected as sample, for its core matter for conducting e-government which major goals and responsibility of Ministry of Information Technology and Communication are maintained and achieved.

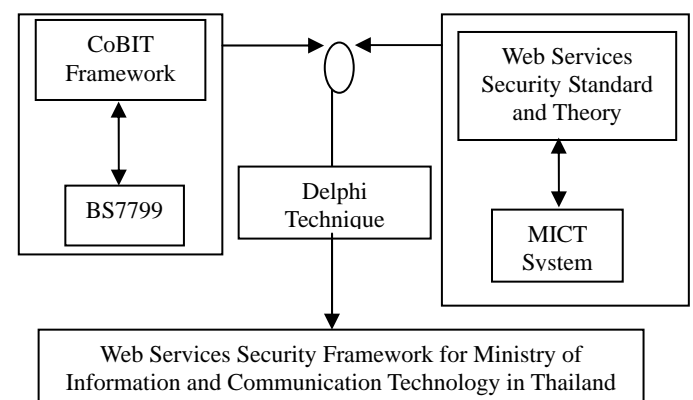


Figure 1: Conceptual design

As illustrated in Figure 1, on the left box is to determine jointing point between COBIT framework and BS7799. When they are applied to Ministry of Information and Communication Technology Web Services, the illustration as shown at the right box. Linkage of left and right box is to determine Web Services Security framework for Ministry of Information and Communication Technology in Thailand.

IV. Research Methodology

This research was applied research with referred to acceptably international standard for creating actually applied framework, or furthered development applied to other related fields in similar way.

Collected data is adopted from secondary data source; research literature, and a wide range of related technical articles and textbooks.

Another data collecting method used was Delphi Technique, which relevant expertise's opinions have been gathered to complement framework.

V. Preliminary Results

According to survey and collect data, we found that web services-related major responsibility of Ministry of Information and Communication Technology is to be navigator in e-government development through web services means, accountable for XML, SOAP, UDDI and WSDL web services creation in preparing process. Thus, the framework outcome is followed as;

1. Interchange or table of connection between requirement of BS7799 and security according to XML, SOAP, UDDI and WSDL.
2. Create ISMS document as specified in table of connection referred to BS7799
3. Add ISMS further information according to COBIT framework
4. Requirement based on BS7799 such as
 - 4.1 Security policy
 - 4.2 Organizational security
 - 4.3 Asset classification and control
 - 4.4 Personnel security
 - 4.5 Physical and environmental security
 - 4.6 Communications and Operations management
 - 4.7 Access control
 - 4.8 Systems development and maintenance
 - 4.9 Business continuity management
 - 4.10 Compliance

In addition, ISMS document used "Plan-Do-Check-Act" (PDCA) model, Plan (establish the ISMS) Do (implement and operate the ISMS) Check (monitor and review the ISMS) Act (maintain and improve the ISMS) and follows as;

- 1 Scope
- 2 Normative reference

- 3 Terms and definitions
- 4 Information security management system
- 5 Management responsibility
- 6 Management review of the ISMS
- 7 ISMS improvement

VI. Conclusion

The result indicated merely piloting development for actual application. Since BS779 requirement is considerably detailed, its connection to web service standard is impossible for all BS7799 detailed requirement. In addition, web service technology has been developed continuously and technically, along with increasingly additional new versions, specialized expertise is needed. Concerning to management and web service security, technical and managerial collaboration is necessary to allow effective regulation.

Framework created has been covered only web service on basic standard and operation by Information and Communication Technology, and not covered overall web service technology and system security modality.

BS7799 has been developed more strictly and progressed to new version of standard ISO27001, including to web service technology as significant element in future information technology. Additional standard prototypes should be given further attention to be researched and created so that they can be applied or established to web service standard particularly.

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The Protection of Privacy in Internet Banking

Ziqi Liao

Department of Finance and Decision Sciences
Hong Kong Baptist University
Renfrew Road, Kowloon, Hong Kong
Telephone: (852) 34115227 e-mail: victor@hkbu.edu.hk

Abstract: This paper explores the consumer concerns about privacy in Internet e-banking and examines the impacts of several variables in relation to perceived privacy protection. The findings suggest that commercial banks must effectively minimize transaction errors, eliminate unauthorized use of personal data, control offensive access and maintain transactions records. Preventive management is vital to the enhancement of privacy of Internet banking and the consumer acceptance of Internet banking services.

Keywords: e-finance, Internet banking, consumers, privacy.

I. Introduction

Internet banking provides an effective electronic channel for delivering banking and financial services and enables individuals to access accounts anytime and anywhere. However, the spread of e-commerce activities increasingly causes privacy concern, which considerably affects the success of different e-businesses. As far as this is concerned, it is important for e-banking service providers to appreciate consumer expectation in privacy protection. This paper examines several variables in relation to the protection of privacy in the case of Internet banking. It also explores the impacts of these variables on consumer acceptance of the e-banking services.

II. Hypotheses

Numerous existing studies have examined the protection of privacy [3] [8] [9] [14] [15] [17]. For instance, Smith, Milberg and Sandra [17] measure individual's concerns about information privacy using several dimensions such as collection, unauthorized secondary use, errors and improper access. On the basis of previous work, this study applies several variables in relation to the perceived privacy and examines their influences in operational environments of Internet banking. These include personal data collection, data errors, unauthorized use of personal data, offensive access control, data loss, perceived privacy, attitude and behavioral intention to use Internet e-banking. Firstly, commercial banks have collected a large amount of personal data for different banking and financial services. Customers may be offended by the request of providing some sensitive

data in relation to individual privacy. Hence, Hypothesis 1 is proposed:

H1: The collection of customer data has a positive impact on perceived privacy.

Secondly, it is practically difficult to completely eliminate deliberate and accidental errors in business transactions. The assurance of data correctness and data integrity remains an important issue [9]. However, some firms have not taken enough steps to minimize errors in data processing [17]. The concern about transaction errors in banking environment may considerably affect individual perceptions of privacy. Therefore, Hypothesis 2 is proposed:

H2: The minimization of transactional errors has a positive impact on perceived privacy.

Thirdly, consumers might worry about that the information collected from individuals is used for unusual purposes without permission. Even within a company, for example, the information collected for research purposes may be used for marketing promotion [2]. In the banking industry, the data collected from loan applications may be used to sort customers into different categories for service promotion. In terms of unauthorized use of personal data, it may include secondary use of information and shares of customer contacts with other firms. As a result, it leads to a negative response from individuals [3] [17]. Therefore, Hypothesis 3 is proposed.

H3: The elimination of unauthorized use of personal data has a positive impact on perceived privacy.

Fourthly, there is a concern about offensive access, because someone is not properly authorized, may be able to view or work with a particular data [15]. The access to individuals account should affect the privacy level especially in e-banking environment. How to effectively control the unauthorized access is a critical administrative issue of an organization [17]. Hence, the following is proposed:

H4: The control of offensive access has a positive impact on perceived privacy.

Moreover, personal data and transaction records might be lost due to the removal of electronic data while it is transited. It might also be lost when someone accidentally erases the data in a database. If an individual assumed that there would be a loss of personal data through the use of an information system, little privacy of the application should be perceived [9]. The storage and data maintenance of

individual data remains an important task especially for bank operations management. Therefore, Hypothesis 5 is proposed.

H5: The elimination of data loss has a positive impact on perceived privacy.

Numerous studies suggest that attitude has a significant effect on behavior intention [1] [4] [5] [6] [7] [10] [11] [12] [13] [16] [18]. Attitude can mediate effective responses between beliefs and usage attention [4] [5]. Increasingly, consumers are seriously concerned about the protection of privacy associated with electronic commerce activities. Empirical work indicates that privacy is a significant factor influencing consumer willingness to use e-banking [15]. In general, those expecting a higher level of perceived security usually have a more favorable attitude towards the service [8]. Therefore, the Hypotheses 6.1 and 6.2 are proposed.

H6.1: Perceived privacy has a positive impact on consumer attitude towards Internet banking.

H6.2: Consumer attitude influences behavioral intention to use Internet banking.

III. Methods

The research methods include survey and statistical data analysis. The questionnaire includes a number of questions in relation to perceived privacy, consumer attitudes and behavior Intention to use Internet banking. In order to ensure content validity of the scales adopted, the items within the questionnaire were developed with reference to the existing literatures. The respondents were asked to indicate whether they have experience on the use of Internet banking. They were also asked to give their observations using a seven-point Likert-scale ranging from 1 to 7. Moreover, they were requested to provide demographic data such as gender, education, income and occupation. As a result, two hundred and ten useful responses were received at this stage. Finally, several procedures of the Statistical Package for Social Science were used to analyze the data collected.

IV. Results and Discussion

Multiple regression analysis has been conducted to test to the above-mentioned hypotheses. The results in Table 1 indicate that several exogenous variables have significant impacts on the endogenous variable ($F = 26.92$, $Sig. < 0.001$) and H2, H3, H4 and H5 are supported. The R^2 value of 0.383 suggests that 38.3% of the variance can be explained. In other words, the minimization of transactions errors, the elimination of unauthorized use of personal data, the control of offensive access, and the protection of customer data significantly affect the perceived privacy of Internet banking. In turn, the perceived privacy significantly affects consumer attitude towards Internet banking ($F = 29.06$, $\beta=0.35$, $Sig. < 0.001$) which also considerably influences their behavioral intention to use e-banking

services ($F = 100.41$, $\beta=0.57$, $Sig. < 0.001$). Therefore, H6.1 and H6.2 are supported.

It is generally understandable that an individual customer must provide necessary personal data when opening an account in a respectable financial institution. Therefore, the bank has little problem on the collection of customer personal data. However, it is desirable that the bank is able to identify any data problems and transaction errors and make prompt corrections in data processing. In addition, the elimination of unauthorized use of customer personal data is critical to the protection of customer privacy. It is not uncommon that some banks may intensively analyze the personal data of customers for the purpose of customer relationship management. Based on data-mining, banks may be able to appreciate the need of different customers. Although the banks usually have particular administrative procedures and regulations for data analysis, consumers are still concerned about the use of personal data. As far as this is concerned, the banks should ask the customers whether they are allowed to use the information for product and service promotions.

Table 1 Results of Regression Analysis

	β	t	$Sig.$
(Constant)		4.518	.000
Data collection	.035	.636	.525
Transaction errors	.166	2.566	.011
Unauthorized use	.231	3.363	.001
Offensive access	.138	2.000	.047
Data loss	.259	3.689	.000

Note: Adjusted $R^2 = 0.383$.

Furthermore, the banks must strictly control offensive access to Internet e-banking systems, in order to effectively protect the privacy of its customers. A consistent investment in the most advanced security technology is critical to enable the banks to immediately identify any unusual attempt to enter an e-banking account and to restrict different offensive attaches to the Internet banking systems. Finally, customers are concerned about the possible loss of transactions data, because it is beyond their control. The banks must be responsible for maintaining transactions records. An effective elimination of data loss should greatly enhance the customers' confidence in Internet banking services. In sum, the findings suggest that commercial banks must minimize transactional errors, eliminate unauthorized use of personal data, stop any offensive access, and maintain the personal data of customers. This will help enhance the perceived level of privacy protection. In order to encourage more people to use of Internet banking, they must adopt a series of security procedures to protect privacy in Internet e-banking services.

V. Conclusion

An understanding of customer concerns and expectations is essential for planning and promoting Internet e-banking services. It is also important for formulating competitive

strategy for business development. This study systematically identifies the privacy concerns from the customer perspective. Preventive management such as minimizing transactional errors, eliminating unauthorized use of personal data, controlling offensive access, and maintaining transactions data are vital to the protection of customer privacy, which also significantly affect individual attitude and behavioral intention to e-banking. The findings have practical implications for managing the existing Internet e-banking systems. Accordingly, commercial banks might develop and implement a series of administrative procedures to protect the privacy and security of e-banking services. Practically, there are various variables associated with the protection of individual privacy in different social and cultural environments. Therefore, the present study can be extended to explore other aspects which might affect consumer acceptance and adoption of Internet e-banking in different contexts.

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Model of Information Security Engineering Based on SSE-CMM

Hong Yang, De-li Yang, Zhi Zheng
System Engineering Research Institute
Dalian University of Technology, China, 116023
EMAIL: yh.Maggie@163.com

Abstract: On the basis of the project thought of SSE-CMM, this paper presents a kind of information security engineering model based on SSE-CMM. And it expounds the concrete work at each stage in the course of security engineering in detail.

Keywords: Information System Security, Information Security Engineering, SSE-CMM

I. Introduction

I. 1 Information security engineering

With the rapid development of information technology and network technology, information system has been paid much more attention and widely used in the various aspects of our society. However, "information system security becomes a key question in the development of the global information society and gets more and more serious since there exists more problems: web attack, virus infected, wrong use by the interior stuff. People take series of measures and technology to grantee the information system security. Such as physical separation, firewall, identity certification, visiting control, identity identification, audit etc. But system security problem is dynamic and covers many aspects: security technology, products, stuff, management and so on. Therefore, information system security is not only a technological process, but a social process as well. It must be dealt with as engineering and solved by the means of system engineering. Therefore the idea of information security engineering is put forward. Information security engineering^[1] is such a process that adopts concept, principle, technology and method of engineering to study, exploit, implement and maintain information and web system security in the enterprise rank. It combines engineering implementation flow, which is proved to be right by time, management technology and the best technology available now. To guarantee information system security according to the idea of information security engineering is to solve various problems in the whole security process.

I. 2 Problems existing in information security engineering

Since the idea of information system security was put forward in 1972, the evolution of the related theories and approaches has experienced several stages. It develops into

LAN, Internet environment from a stand-alone environment and changes its service object from the military field to commercial organization. It takes the approaches of system engineering as a comprehensive way to tackle all the problems rather than just unitarily depend on the technology^[2].

Traditional system security engineering is regarded as a special engineering activity. Its aim is to apply the information protection technology to the established system structure and design norms. It focuses on the final system and products. Furthermore, it usually does not take the investigation about the basic protection demand of the company. This kind of approach lacks of the process control of the information system security structure and makes the security engineering activity separate from the system engineering activity. This will bring about the problem about the security vulnerability and lead to the system unsteadiness. In order to solve these problems and make it well applied, the information system security must be combined with the system engineering and the information system engineering must be integrated. It should be a process going in step with the process of the integrated system engineering. If it does not run like this, it will result in the uncertainty of the measures of system security. Then the users cannot get the available risk rank of the system correctly.

I. 3 The significance of researching information security engineering

The significance of researching information security engineering is determined by the properties^[3] of the information security.

(1) Information security is of sociality

The content of information security assurance is more universal and comprehensive than ever before.

(2) Information security is of comprehensiveness

Information security problems should be considered in overall aspects and the extent of the system security depends on the weakest part of the system.

(3) Information security is a process and has lifecycle

A holistic security process include at least the confirmation of security target and principle, risk analysis, requirement analysis, security strategies research, security architecture research, the confirmation of security implementation field, testing and selecting of security technology and products, security engineering implementation, security engineering implementation

surveillance and management, security engineering test and running, education on security consciousness and technology training, security assessment and examination, emergency response etc. This is a lifecycle of holistic information security engineering. After security assessment and examination, a new lifecycle begins. This is a continuously to-and-fro and upward corkscrew security model.

(4) Information security is dynamic

Information technology is developing, while the level of the hacker is also improving. Security strategies, security architecture and security technology should be adjusted dynamically in order to make the security system function furthest. Then the whole security system will be in a dynamic process and keep on renewing and improving.

(5) Information security has multi-levels

Multi-level security technology and approaches should be used to remove security risk.

(6) Security is relative

Security is relative. Absolute security does not exist.

Therefore, information security engineering is complicated system engineering. It involves exploitation, integration, operation, maintenance and management of information system. It is closely linked with web integration, exploitation and application. With the dramatic increase in informatization degree of our country's national defense, government, enterprises and society, the challenge of information system security becomes more and more serious. SSE-CMM is not practical in operation; In addition, the research on information security engineering is not mature in our country. In this case, to modify and improve SSE-CMM and to conduct research on its engineering, practicability under our country's circumstances is of great realistic significance to guide the development of information security engineering in our country.

II. General Research At Home And Abroad

There are two kinds of research thoughts in the history of information security engineering approach development.

One thought is ISSE (Information System Security Engineering), based on the system engineering process approach. The idea of ISSE appears as early as 1993 in the <handbook of information system security engineering> constituted by the state security administration in the U.S.A. ISSE puts emphasis on the application system engineering of information security. Specifically speaking, information system security engineering is to apply the special security technology (communication security technology, computer security technology and internet security technology) to the each stage of the information system lifecycle in order to guarantee the demands for the information system to be satisfied by following the viable security strategies and at

the same time to resist the appreciable threats. It is a methodology that demarcates the engineering elements by time-dimension. There should be many requirements running through the whole process, especially the assurance requirement of information security, but ISSE lacks of the special discussion on this issue. Besides, the content of information security is very complicated. One holistic process of information security engineering usually involves many complicated security fields, however, the time process does not show clearly in some fields^[1].

The second thought is SSE-CMM (System Security Engineering Capability Maturity Model) based on the process capability maturity model. It roots in CMM, put forward by information security technicians from NSA. It was first published in Oct 1996 and renewed in Apr 1999. This model tries to make information security engineering become a mature measurable advanced subject by taking the process management.

Information security engineering has been studied for over 10 years abroad. The researchers in different countries have put forward various methods. Literature^[4] puts forward an example of SLPS (Software Lifecycle Process Standard) based on IEEE/EIA12207, which is a information system security engineering model. Literature^[5] discusses the viewpoint of information system security analysis and design based on BPM technology. It combines security risk analysis and organization operation process analysis. Literature^[6] analyzes a series of information system security processes about how to define and transfer risks, how to integrate security to target structure and how to deal with the original system limitation when many systems are integrated to a larger one. Literature^[7] shows the idea of increasing the systematic structure related to security levels. This idea aims at Web applications and is based on SSE-CMM with 3 levels. Literature^[8] advances another method, which regards security as a part of the exploitation of the whole system.

The research on information security engineering theory and approaches in our country has just begins. At present, the research is mainly based on the model SSE-CMM. Literature^[9] advances the thought and ways of exploitation and introduces the basic thought and architecture of this model. Literature^[10] put forwards the V lifecycle model on the basis of this model. Literature^[11] bring forwards the opinion that complicated information system security engineering management can be turned into a strict dependable system by SSE-CMM and demonstrates its structure, property and application. Literature^[12] advances information system security lifecycle model, which centers the risk analysis. It is also based on SSE-CMM and aims at the lifecycle of information system.

III. Research Approaches

Since information security is a matter of system engineering based on process, the model SSE-CMM can be regarded as the theoretical basis of the information security engineering management and can be used to guide the specific

management tasks in the process of the security engineering implementation. This model is based on the process and dynamically controlled.

III. 1 System Security Engineering Capability Maturity Model

The SSE-CMM has two dimensions, “domain” and “capability.” The domain dimension contains 11 process areas, which cover all major areas of security engineering. They are Administer Security Controls, Assess Impact, Assess Security Risk, Assess Threat, Assess Vulnerability, Build Assurance Argument, Coordinate Security, Monitor Security Posture, Provide Security Input, Specify Security Needs and Verify and Validate Security. The SSE-CMM divides security engineering into three basic areas: risk, engineering and assurance.

Among them, risk process refers to the risk analysis focusing on the system plans to implement security engineering. It analyzes all kinds of elements that probably threaten the system, the vulnerability of the system itself and the influence on the system if the threatening elements play a role. Engineering process is a complicated process. According to the result of the risk analysis, some related system demands and applicable laws and policies, the engineering stuff and the clients together identify and define the system security demands. Then they found out the project after considering all the elements, such as cost, quality, technology risk and the difficult degree of use etc. This project is used to guide the exploitation and construction of the security system and test it continuously to guarantee the risk not to reach the unacceptable degree. Assurance process is to test and validate the process of security engineering and the result of the quality and consequently make sure whether the system security is credible. With the incessant implementation of these three processes, the process ability of the engineering stuff grows unceasingly.

SSE-CMM itself is not a security technology model, but it offers the key process areas of information security engineering. It can guide each part of the whole engineering and consequently turn the complicated information system security construction into a strict engineering architecture.

III. 2 Information security engineering model based on SSE-CMM

Just like above description, SSE-CMM is a security framework model. It should combine the practical circumstances to discuss the approaches when implementing security engineering. So a model of information security engineering based on SSE-CMM is produced. It combines the security process put forward by academician Shen Chang-xiang.

Figure 1 demonstrates a holistic periodicity of information security engineering. This is a continuously to-and-fro and upward corkscrew security model. It starts from confirming security target/principle, then passes security risk analysis and other series of process, at last comes to security

assessment /examination. Then a new periodicity begins.

(1) Confirm security target and principle

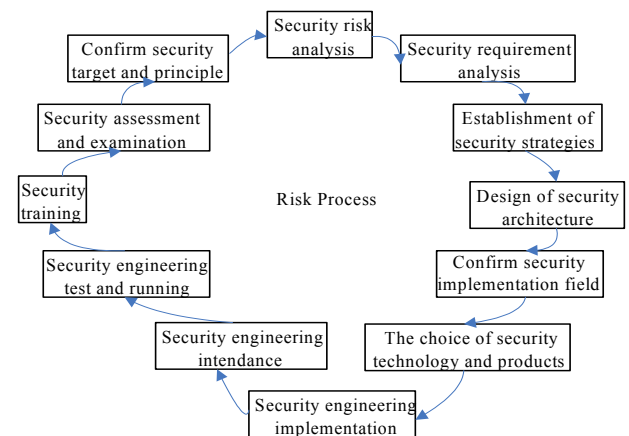
The intended security target and principles of the information system should be confirmed according to the system security requirement and the standards of the country and the same industry as well as the related policies and rules.

(2) Security risk analysis

Security risk analysis is an effective way of assessing information security. According to the confirmed security target and principle, it can focus on the unsafe elements to analyze the security risks that exist in the system, such as the system threats and vulnerability and the risks that they result in. It can assess the intending loss quantity happened to the whole system once the resource get short or is damaged.

There are many ways of doing risk analysis. They can be classified into three types: quantitative risk analysis approaches, qualitative risk analysis approaches and the hybrid risk analysis approaches of the both.

Fig. 1 Model of information security engineering based on SSE-CMM



(3) Security requirement analysis

Security requirement analysis is to investigate the information system on the base of the security risk analysis. The investigation should be all-round, systematic and detailed. Its aim is to ensure the system target, collect the datum and demands for them and make sure the users' requirement. Requirement analysis is a process of further understanding and describing the object system.

(4) Establishment of security strategies

System security strategies should be put forward on the base of the result obtained by analyzing the information system risk. The establishment of them should also be combined with security target and security requirement, besides following the related information security standards and rules. System security strategies are the guidance of the further design of the security system. They are the rules and responsibility that all the departments and stuff in the

organization should abide by. They provide a guide framework to guarantee the information system security.

(5) Design of security architecture

Information system security structure is to put the secure elements into the information system structure, and make a description about the relationship among the elements concerned with the fulfillment of security, that is, to describe how the system is organized to meet the security need and make the information system security be an all-around, comprehensive and multi-level holistic security framework.

(6) Confirm security implementation field

The specific implementation field of security strategies should be confirmed.

(7) The choice of security technology and products

Security technology and products should be chosen based on the security architecture. The optional security technology are like these: identity certification technology, digital signature technology, visit accreditation management technology, web supervisory technology, technical segregation technology and interdiction technology etc. Security products are firewall, identity certification system, visit control system, VPN channels, and so on.

(8) Security engineering implementation

The core in the period of security engineering implementation is to establish security baseline used in the whole process management according to the property of the information system and security requirement. In the process of implementation, specific technology and management approaches should be adopted based on the different information systems.

(9) Security engineering intendant

Each part of the whole security engineering should be supervised and examined. Such as flow, rate of progress and quality.

(10) Security engineering test and running

Security engineering should be tested and run in order to find out hidden troubles and careless omission of security, and then the engineering quality can be improved.

(11) Security training

All the staff in the organization should receive the education on the consciousness of security and get the technology training.

(12) Security assessment and examination

Security of information system should be assessed according to the assessment standards and guideline. At the same time, the implementation of information system security strategies should be also examined. The faultiness of requirement analysis should be found out timely in order to improve security strategies.

IV. Conclusion

In the face of hidden trouble and crises of the information era, information system security is not just the simple accumulation of technology and security products. It must be dealt with by means of theories and approaches of information security engineering. However, information security engineering is still faced with a great challenge since the information security engineering standards at home and abroad have just been published. Therefore, the approaches and model of information security engineering as well as the specific guidelines focusing on the different kinds of information system need further research.

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Towards a Code of Cyberethics for a Municipality in South Africa

Udo Averweg

Information Services Department, eThekweni Municipality and University of KwaZulu-Natal

P O Box 828, Durban, 4000, South Africa

Telephone: +27 (31) 311-1905

Telefax: +27 (31) 304-6730

e-Mail: averwegu@durban.gov.za

Geoff Erwin

Faculty of Business Informatics, Cape Peninsula University of Technology

P O Box 652, Cape Town, 8000, South Africa

Telephone: +27 (21) 460-3232

Telefax: +27 (21) 460-3985

e-Mail: erwing@cput.ac.za

Abstract: Cybertechnology has had a significant impact on our social and moral systems. Ethics is a branch of philosophy that deals with what is considered to be right and wrong. One of the ways in which ethical standards in the public service in South Africa can be promoted is by developing Codes of Conduct that set a standard of behaviour to be followed within specific occupational categories. One occupational category is Information and Communication Technologies (ICT). The diversity of ICT applications (such as supply chain management) and the increased use of ICT (such as e-Business) have created a variety of ethical issues. Kantian Ethics is based on the idea that duty is fundamental and 'principle based'. The authors suggest that principle based theory should serve as backdrop to a Code of Cyberethics for a public service entity (a metropolitan municipality) in South Africa.

In this paper the concepts of cybertechnology and cyberethics are introduced. eThekweni Municipality, the most populous municipality in South Africa, is selected as the environment for the formulation of a Code of Cyberethics. The methodology for the formulation of a Code of Cyberethics for eThekweni Municipality is described.

Keywords: Cyber Law, Cyberethics, Intellectual Property Rights.

I. Introduction

Cybertechnology has had a significant impact on our social and moral systems. Ethics is a branch of philosophy that deals with what is considered to be right and wrong. Ethics is the study of what is good or right for human beings [9]. During the years, philosophers have proposed many ethical guidelines. It should, however, be noted that what is unethical may not necessarily be illegal. Thus, in many instances, an individual or organisation faced with an ethical issue is not considering whether to break the law. One of the ways in which high ethical standards in the public service

can be promoted is by developing Codes of Conduct that set a standard of behaviour to be followed within specific occupational categories [7]. One occupational category is Information and Communication Technologies (ICT). In this paper the formulation of a Code of Cyberethics for eThekweni Municipality in South Africa is described.

Cyberethics can be understood as a branch of applied ethics [26]. In today's complex environment, interpretations of 'right' and 'wrong' are not always clear. 'Right' actions are those that it is useful to praise, 'wrong' actions are those that it is useful to blame [17]. The 'right' ethical answer may or may not be the answer that is prescribed by law; in fact depending on the ethical assumptions made, the two may on occasion be in conflict [18]. The challenge is to make essential ethical decision-making explicit so as to make it better [21]. Although tailor-made Codes of Conduct will not be sufficient in themselves, they should be viewed as an integral part of integrating ethics management with the broader public management environment [7].

Many organisations develop their own codes of ethics. A code of ethics is a collection of principles intended as a guide for employees in an organisation. The diversity of ICT applications (such as supply chain management) and the increased use of ICT (such as e-Business) have created a variety of ethical issues. Ethical theories are theories about justifying our moral actions [16]. They propose the appropriate reasons on which our moral decisions should be based. The structure of this paper is as follows: Ethical theories with a focus on principle based theory are introduced. The concepts of cybertechnology and cyberethics are discussed. The methodology for the formulation of a Code of Cyberethics is described. Some concluding remarks are then given.

II. Ethical Theories

During the past centuries, a broad range of ethical theories has been developed to identify how we should determine what is actually good not only for one's self but also for others. Ethical theories attempt to answer the question, why

be ethical? Ethical theories provide a framework for analysing moral issues via a scheme that is internally coherent and consistent as well as comprehensive and systematic [26]. From the literature, one key ethical theory is Kantian Ethics.

One of the basic tenets of Kantian Ethics is based on the idea that duty is fundamental and is 'principle based'. Principle based theory is one that bases the value of an action on the nature of the action itself. One advantage of duty ethics is that it gives a powerful and clear framework for stating codes of ethics. Another advantage is that it is impartial: the same rules apply to all persons. For example, eThekweni Municipality's published Disciplinary Procedures, applies to all its employees. It is argued that principle based theory should therefore serve as backdrop to formulating a Code of Cyberethics.

II. 1 Principle Based Theory

Principle based theory emphasises that moral actions should be in accordance with a pre-established rule or rules. The expectation is that progress toward an objective standard of moral behaviour will be made if people based their actions on fixed rules. It is argued by the authors that an example of fixed rules, is a Code of Cyberethics.

A well-known proponent of a rule based theory is Immanuel Kant (1724 - 1804). He was convinced that all rational thinking people should be able and willing to subscribe to a basic rule that should govern all moral behaviour. This basic rule can be expressed as follows: act in such a way that your action could be a universal law. Kant was convinced that such a strategy will improve the quality of moral decisions and enhance the respect that people pay each other [16]. One advantage of this approach is that it provides for the obligations that we have towards other persons (for example, ICT software developers) in our respective social roles. One problem associated with this approach is that contrary to Kant's expectation, all rational thinking people do not conclude to the same rules for moral behaviour. For example, in the ICT domain there may be dissension whether one may distribute copies of downloaded music from the Internet using, for example, eThekweni Municipality's ICT infrastructure.

In South Africa, legislation compels municipal officials and councillors to make full disclosures in respect of gifts and business interests in respect of municipal tender processes. With effect 1 October 2005, eThekweni Municipality was required by law to bring into effect a supply chain management policy that will revolutionise the way it undertakes business (including e-Business) and to ensure greater transparency and fairness in the tender process. As a result hereof, eThekweni Municipality has 'decided to introduce a set of processes and ethical standards which ... will allow us to stop practices and ensure greater transparency' [21]. The concept of cybertechnology is now discussed.

III. Concept of Cybertechnology

Cybertechnology refers to a wide range of computing and communication devices, from stand-alone computers to 'connected' or networked, computing and ICT [26]. Networked devices can be connected directly to the Internet or to the other devices through one or more privately owned computer networks. Privately owned networks, in turn, include Local Area Networks (LANs) and Wide Area Networks (WANs). The Internet and privately owned computer networks, such as LANs and WANs, are perhaps the most common and well-known examples of cybertechnology. Cyberethics refers to the study of moral, legal and social issues involving this technology. The focus of this paper is on the moral issues embraced by cyberethics from a principle based theory perspective.

IV. Cyberethics

Some researchers use the term 'computer ethics' to describe the field that examines moral ethics pertaining to ICT, see for example, [8] and Johnson [10]. With concerns about ethical issues involved (the Internet in particular), other researchers use the term 'Internet ethics' [11] instead. It is felt by the authors that ethical issues are not limited to the Internet or to computing machines as they also include privately owned computer networks and ICT. Hence for the purposes of this paper, the relatively new term 'cyberethics' [19, 26] is used to capture some of the wide range of moral issues involving cybertechnology.

It is proposed that cyberethics is a more accurate term than either 'Internet ethics' or 'computer ethics' for two reasons:

- the term 'computer ethics' can connote ethical issues construed as pertaining to stand-alone or 'unconnected' computers. However, with the advent of networked systems, a computer system may nowadays be thought of more accurately as a new kind of *medium* as opposed to a *machine*; and
- the term 'computer ethics' may suggest a field of study that is concerned exclusively with ethical issues involving ICT professionals. The field of cyberethics is not linked to an analysis of moral issues that affect only these professionals [26].

Crimes committed in cyberspace require cyber laws. At the Convention of Cybercrime held on 23 November 2001 in Budapest, Hungary, thirty member states of the Council of Europe signed the first international treaty on criminal offences committed against or with the help of ICT such as the Internet.

IV. 1 Codes of Ethics

The value of codes is often overstated: on their own and unaccompanied by the appropriate habits, expectations and sanctions, codes of conduct are of little value [21].

Furthermore the appropriate basis for codes of conduct is often equally misunderstood: what legitimises codes is not stakeholder consent but ethical content. Nevertheless, codes of conduct (such as a proposed Code of Cyberethics for eThekweni Municipality) can be extremely useful. By communicating corporate purposes explicitly regarding controversial matters (such as copying someone else's software for personal use) and by clarifying which stakeholder expectations are legitimate, codes of conduct can eliminate ignorance as an excuse. Furthermore they can be an effective tool for sharpening business accountability and improving corporate governance. For example, while eThekweni Municipality respects the rights to privacy, it will make information available at its website at <http://www.durban.gov.za> to ensure that its supply change management policy is transparent [25].

An information governance framework should contain measurable and strategic goals which will be beneficial for the provider and citizens and promote ethical standards. For eThekweni Municipality's supply chain management policy, a 'code of ethical standards has been established for officials to promote mutual trust and respect and provide where business can be done with integrity' [25]. Professionals in the public service are custodians of the public trust and therefore have to be worthy of that trust [7]. For a discussion of a trust model for e-Business in South Africa, see for example, [4].

Codes must be properly structured and should not reflect the prevailing values or culture of the organisation (such as eThekweni Municipality). For example, when the existing culture is less than perfect, enshrining it in a code merely reinforces bad practice - what it prescribes must be better than the existing norm. A code of conduct is **not** a survey of employees' ethical attitudes [21]. It is meant to express, for example, eThekweni Municipality's fundamental aims and values and it is for the eThekweni Municipality to state what those aims and values are. It sets out what constitutes ethical conduct for the business (such as e-Business) and its validity depends solely on the correctness of the values and principles it expresses - not on employee agreement. Ideally, stakeholders will share the values embodied in the code. However, if they do not it is the stakeholders (eThekweni Municipality employees) and not the code which should be changed. One needs to take 'into consideration that citizens' expectations of government are to a large extent influenced by their interaction with municipalities, mainly because of the types of services that are rendered' [7]. Such are the challenges for the formulation of a Code of Cyberethics for eThekweni Municipality.

Codes of ethics involve the formalisation of some rules and expected actions [27]. Violation of a code of ethics may lead to the termination of employment. Similar procedures exist in eThekweni Municipality's Disciplinary Procedures. Codes of ethics are valuable for raising awareness of ethical issues and clarifying what is acceptable behaviour in a variety of circumstances. In the case of eThekweni Municipality, an ICT Code of Cyberethics does not exist and

the formulation of one is required to prevent Internet abuse and misuse by employees. Organisations are increasingly faced with serious legal and liability issues stemming from wrongful use of software by their employees [22].

The acceptance of a Code of Conduct is a very central part of being a professional [7]. Codes of ethics have limitations because of their nature to generalise acceptable behaviour - despite the variations in social and ethical values that may exist in different communities. This will need to be taken account of when formulating a Code of Cyberethics for eThekweni Municipality. For example, it will be arrogant to impose on eThekweni Municipality employees the ethical ICT standards developed in and appropriate for Hong Kong, or indeed doing the reverse. However, such impositions do appear to be commonplace and they tend to lead to outright rejection (rather than to higher ethical standards, which may be the intention). The stakeholder theory of business typically holds that business is accountable to all its stakeholders and that the role of management is to balance their competing interest [21]. According to eThekweni Municipality's Disciplinary Procedures, the 'maintenance of discipline is the responsibility of management'.

IV. 2 Employee Involvement

Employee involvement can be valuable [21]. A code will be most effective if it addresses matters which actually cause concern. Sternberg [21] suggests that it is sensible to consult stakeholders (especially employees) to determine what situations are genuinely problematical. This approach was undertaken by the authors. Informal discussions were held by the first author with colleagues at eThekweni Municipality. Some of the cybertechnology and related concerns raised by these colleagues are reflected in Table 1.

Table 1. Cybertechnology and related concerns raised by the first author's colleagues at eThekweni Municipality

No	Concern raised
1	May I copy someone else's software for my own personal use and distribute it?
2	May I download music/video from the Internet for personal use and distribute it?
3	May I access private and confidential information without consent and distribute it?
4	May I access other's desktops or laptops without consent?
5	May I take programs that I have done for eThekweni Municipality and keep it for personal use or use it at another employer?

Consultation can provide useful information about the stringency (or laxity) of employees' ethical standards and the degree of ethical diversity prevailing in eThekweni

Municipality's heterogeneous workforce. Furthermore by making eThekweni Municipality employees part of the code-making process may improve compliance with the Code of Cyberethics: since employees feel that they have had a role in formulating it, they are more likely to understand the code and observe its strictures. However, human beings are generally capable of discovering the modes of life that are best suited to themselves as individuals [24]. Research into why so many Codes 'die' indicates that many things can go wrong in the process of institutionalising codes [7]. These mistakes can include the way the Code was developed, written, distributed and enacted.

Once the Code of Cyberethics has been formulated and adopted by the eThekweni Municipality Strategic Management Team (Stratman), the document should form part of the City Manager's Standing Orders. Publishing a formal code serves as an explicit signal of eThekweni Municipality's commitment to ethical business conduct. By proclamation and Stratman endorsing the values it proclaims, they must make it clear that it will be enforced and they also show that they consider themselves to be bound by it. To be worthy of respect, the adopted Code of Cyberethics must apply and be seen to apply to every employee in eThekweni Municipality. This underscores one of the advantages of duty ethics.

IV. 3 Intellectual Property

Intellectual property is the intangible property created by individuals or organisations. To varying degrees in different countries, intellectual property is protected under laws relating to copyright, trademarks, patents and trade secrets. The copying of software is generally seen to be of greatest concern - at least to the software developers [27]. Software piracy, the unauthorised copying of computer software, is widespread in many organisations today [12]. In eThekweni Municipality's Disciplinary Procedures, an employee may be dismissed for dishonest behaviour or wrong disclosure of privileged information.

The topic of intellectual property rights (IPR) is seen to be important since it relates to the fundamental right to private property - especially property that represents the fruits of one's endeavours, see for example, [13]. IPR protects the way ideas are expressed but not the ideas themselves [27]. IPR may be seen as a mechanism for protecting the creative works of individual people and organisations. However, this is problematic in societies that place less value on individual freedom and more on social order. In many developing countries, Steidlmeier [20] suggests that 'individual claims on intellectual property are subordinated to more fundamental claims of social well-being'. In these countries (including South Africa), the welfare of society is considered to be more important than that of any individual.

Much of the IPR discussion relates to the debate about rights and duties. Software developers demand the right of stringent legal protection for the fruits of their labour and compensation for resources expended in software

development. Consequently consumers are then deemed to have a duty to pay for that software (whether it is in code, music, video or other digitised forms) and to respect the intellectual property by not stealing (copying or downloading it, for example, from the Internet).

V. Data and Information Privacy

The notion of privacy has become one of the most contentious issues of the global information age due to the capability of computers to perform actions previously impractical or impossible. Computers are able to advance exponentially and make unmanageable tasks practically possible [5].

Table 2. Summary of six data protection principles from the Office of the Privacy Commissioner's Office for Personal Data, Hong Kong (Source: Retrieved 10 October, 2005 from <http://www.pco.org.hk>)

N o	Narrative	Associated Explanatory Text
1	Purpose and manner of collection	Data should be collected in a fair and lawful manner. Data users should explain to data subjects what data is being collected and how it will be used
2	Accuracy and duration of retention	Personal data that has been collected should be kept accurate, up-to-date and for no longer than is necessary
3	Use	Data must be only be used for the specific or directly related purpose for which it was collected. Any other use is conditional on consent of the data subject
4	Security	Suitable security measures should be applied to personal data
5	Information availability	Data users should be open to the kind of data they store and what they use it for
6	Access	Data subjects have the right to access their personal data, to verify its accuracy and to request correction

Agranoff [1] defines (data) privacy as the 'claim of individuals, groups or institutions to determine for themselves when, and to what extent, information about them is communicated to others'. Charlesworth and Sewry [5] note that privacy includes considerations of the conflicts between society's right to know and individual's right to privacy. Nevertheless the right to privacy is not absolute. It

varies considerably in different cultures, as it has to be balanced by society's right to know. A detailed set of data privacy principles comes from the Privacy Commissioner's Office for Personal Data (PCOPD), Hong Kong and promulgated in December 1996. A summary of the six PCOPD data protection principles is reflected in Table 2.

These principles are designed to enshrine the reasonable rights and duties of both the data subject (the person described by the data) and the data users (those who possess the data). Sternberg [21] states there is a fundamental importance of accountability to ethical business conduct and good corporate governance. This researcher suggests that the tools which can be used to promote accountability is a code of conduct.

VI. eThekwini Municipality Environment

Following South Africa's second local government elections held on 5 December 2000, in terms of Proclamation 343 of 2000 (KwaZulu/Natal) dated 19 September 2000, the new Durban Metropolitan Uicity Municipality (DMUM) came into existence in the province of KwaZulu/Natal, South Africa. DMUM has subsequently been renamed to eThekwini Municipality. eThekwini Municipality comprises the former Durban Metropolitan Council (which includes the North Central and South Central Councils), the North Local Council, the South Local Council, the inner West City Council, the Outer West Local Council and the Umkomaas Transitional Local Council. For a discussion of ICT considerations in the eThekwini Municipality Area, see for example, [2, 3].

eThekwini Municipality employs approximately 22,000 employees. There are some 6,000 networked desktops (personal computers, thin clients and laptops) and electronic communication is via Novell's GroupWise (Client version 6.5). A total of 5,806 GroupWise accounts are in existence. There are approximately 1,500 Internet accounts utilising either Internet Explorer or Netscape Navigator web browsers. Given the magnitude of this ICT connectivity in terms of LANs and WANs and the potential for abuse and misuse of cyberotechnology by employees, there is thus a need to formulate a Code of Cyberethics for eThekwini Municipality.

The methodology for the formulation of the Code of Cyberethics for eThekwini Municipality is as follows:

- disseminate the authors' validated survey instrument (see extract in Table 3) to eThekwini Municipality employees who have Internet accounts;
- qualitatively and quantitatively analyse the responses received to completed survey questionnaires. From the scored responses, themes, patterns and trends will be synthesized. Sturgeon [23] notes that ethics is an appropriately empirical discipline;
- draft a proposed Code of Cyberethics based on eThekwini Municipality's (1) vision and mission; (2) moral and social values which the organisation wants reflected in all its activities; and (3) values that

reflect characteristics of the organisation's approach to achieving its mission. Particular attention is to be paid to cyberotechnology situations which appear to be genuinely problematic;

- when the Code of Cyberethics is breached, eThekwini Municipality's Standard Disciplinary Procedures must be followed. The Code of Cyberethics should form part of an eThekwini Municipality employee's Conditions of Service;
- present the proposed Code of Cyberethics to eThekwini Municipality's Stratman for ratification and adoption;
- incorporate the document in the City Manager's Standing Orders; and
- utilise an appropriate and effective communication mechanism for the adopted Code of Cyberethics to eThekwini Municipality employees.

Table 3. Extract of Ethics Statement Survey for eThekwini Municipality employees

(Acknowledgement: This extract is an adapted version of the Ethics Statement Survey by Alan Peslak, Penn State University, Dunmore, PA, USA. Retrieved 10 October, 2005 from <http://wsistdevel.sn.psu.edu/ist/arp14/eths1/webform1.aspx>)

Please indicate your level of agreement/disagreement with the following information and communication technology related statements.

Strongly agree - Agree - Undecided - Disagree or Strongly disagree

I may copy someone else's software for my own personal use

- G Strongly agree
G Agree
G Undecided
G Disagree
G Strongly disagree

Please tick any of the following factors that affected your answer (you may tick more than one)

- G I believe that the potential harm done to others would be minimal
G I believe that most view this activity as acceptable
G I believe that any harm that would take place would be to people I do not know
G I believe the number of people harmed would be minimal
G I believe that negative effects of this action would occur a very long time from now
G I believe that the potential harm done to others would be high
G I believe that most view this activity as wrong
G I believe that any harm that would take place would be to people I know
G I believe the number of people harmed would be high
G I believe that negative effects of this action would occur very soon

McCabe [14] found the existence of a corporate code of ethics was associated with significantly lower levels of self-reported unethical behaviour in the workplace. Ethics is not just about Codes – a code is only a small element of the process. Since eThekwini Municipality is about employees and structures (and not only documents), one needs to ensure that both employees and structures within which people

operate support ethical practices. It is argued by the authors that the approach described above will underscore Kant's rule based theory whereby the principle of an action that is being considered becomes the basis for everyone's action in eThekweni Municipality and all its employees will be willing to live in such a society as defined by the adopted Code of Cyberethics.

VII. Conclusion

Cleek and Leonard [6] state that 'emphasis should be placed on how the codes are communicated, enforced, and used, as a basis for strengthening the culture of the organization'. McClenahan [15] suggests that 'being consistent in policies and actions, rewarding ethical conduct, treating employees fairly, and providing better executive leadership' work best to reduce unethical conduct. A commitment to the moral treatment of employees is one of the preconditions for continued excellence [16]. Effective communication of the Code of Cyberethics to eThekweni Municipality employees can help eliminate situations wherein employees complain that they have not been made aware of corporate expectations regarding private Internet usage. Furthermore the development of a Code of Cyberethics will also ensure that its supply chain management and e-Business responds effectively and efficiently to citizens' needs and improve the communication process with citizens.

A proposed statement of core values and a corporate Code of Cyberethics that is effectively communicated and reinforced by strong eThekweni Municipality management support, enforcement processes that support employees when they are faced with difficult dilemmas should help eThekweni Municipality create and maintain an environment conducive to ethical decision-making. With such an environment, there is a strong likelihood that situational characteristics of a dilemma will cause an eThekweni Municipality employee to reach an unethical decision should be reduced.

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Document Recommendation in Organizations with Personal Folders

Chiu-Wen Huang, Chin-Hui Lai, Duen-Ren Liu
Institute of Information Management
National Chiao Tung University
Hsinchu, Taiwan

Abstract: In organizations, knowledge workers usually have their own personal folders that store and organize needed codified knowledge (textual documents) in taxonomy. In such personal folder environments, providing knowledge workers needed knowledge from other workers' folders is important to facilitate knowledge sharing. This work adopts recommendation techniques to provide knowledge workers needed textual documents from other workers folders. Experiments are conducted to verify the performance of various methods using data collected from a research institute laboratory. The result shows that the CBF approach outperforms other methods.

Keywords: Knowledge Management, Document Recommendation, Collaborative Filtering, Content-based Filtering.

I. Introduction

Sharing sustainable and valuable knowledge among knowledge workers is a prominent activity of knowledge management. Organizational knowledge and expertise are usually codified into textual documents, including forms, letters, papers, manuals and reports, to facilitate knowledge capture, search and sharing [7].

Knowledge workers tend to keep their codified knowledge in their own personal folders. Textual documents stored in each worker's personal folder are usually organized into categories in taxonomy. In such personal folder environments, providing knowledge workers needed knowledge from other workers' folders is important to facilitate knowledge sharing. Conventional knowledge management systems (KMSs) have provided search function to help knowledge workers find needed knowledge. However, very few KMSs have considered the issue of proactively providing knowledge workers needed knowledge in personal folder environments.

Recommender systems [2] seem to be an effective solution for proactively providing knowledge workers needed knowledge. Conventional application domains of recommender systems are "Music", "Movie" or "Product" recommendations. Various recommendation methods have been proposed for recommender systems. Collaborative Filtering (CF) assumes that items (e.g. documents) from like-minded users are often relevant. Collaborative filtering utilizes preference ratings given by various users to

determine recommendations to a target user based on the opinions of other similar users. Content-based Filtering (CBF) utilizes profile matching to determine recommendation to target users. In application to recommend documents, Content-based filtering provides recommendations by matching user profiles (e.g., interests) with content features (e.g., feature vectors of documents). Each user profile is derived by analyzing the content features of documents accessed by the user.

LIBRA system [6] is an example of content-based filtering, which recommends books based on book information extracted from Web pages. Siteseer [8] used collaborative filtering to provide Web page recommendations based on the bookmarks of the user's virtual neighbors without considering the categorization of bookmarks. Knowledge Pump [4] used CF techniques to recommend documents based on personal profiles of interest. In these systems, each user stores his/her documents in a commonly agreed classification scheme rather than a personalized one.

RAAP [3] is an example of hybrid system developed to classify and recommend bookmarks retrieved from the Web. The InLinx system [1] also supports the classification and recommendation of bookmarks retrieved from the Web based on content analysis and virtual clusters. Middleton et al. [5] presented an ontological user profiling approach to recommend academic papers. Recommended papers are those match the user's profile and have also been read by similar users.

This work investigates recommendations of textual documents in personal folder environments. Each knowledge worker has his/her own folder that store documents into personalized categories, namely categories defined by himself/herself. We adopt recommendation techniques to provide knowledge workers needed textual documents from other workers folders. Conventional document recommender systems assume a common category schema without considering personalized categories. Our proposed approaches combine filtering and text categorization to recommend documents to target worker's personalized categories. The recommendation proactively notifies knowledge workers regarding peer-reviewed documents, and therefore knowledge diffusion is evolved from 「Pull」 to 「Push」. By means of knowledge diffusion, knowledge workers can learn from each other and eventually elevate work productivity and efficiency. Experiments are conducted to verify the performance of various methods using data collected from a research institute laboratory.

II. Methodology

This section presents the proposed document recommendation methodology that aims to fulfill the goal of push-mode knowledge diffusion. In the organization, documents, manuals, reports, know-how and the like from people in the same project team or from people with similar working experience are of great help. Fig. 1 shows knowledge sharing in personal folder environments. Knowledge workers used to manage his owned document repository by storing documents in different categories. Each knowledge worker shares their own documents to others.

The proposed methods recommend documents stored in other knowledge workers' folders to the target worker's right category. One of the ways to reuse the knowledge in the enterprise is to sharing the knowledge by interflow of knowledge documents. However, the received documents are another burden because knowledge workers have to spend time on managing them. Classification is the basic to manage documents for users to quickly access and store them. However, different people have different criteria to classify documents.

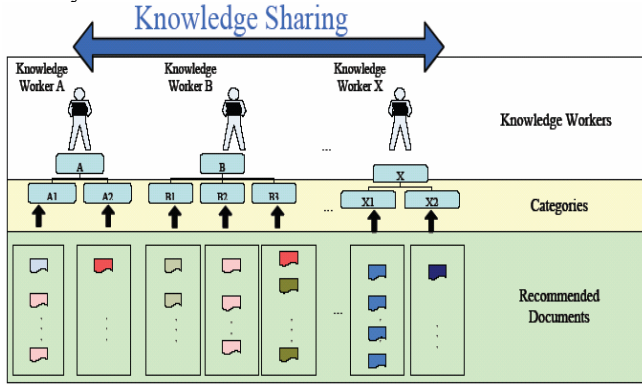


FIG. 1. Recommendation for knowledge sharing

Our approach tries to find the recommendation candidates by examining the document and category profiles to predict if a document is suitable to be recommended to the target category. We proposed two kinds of recommendation methods: content-based filtering and collaborative filtering in order to recommend documents in the personal folder environment. As a result, explicit knowledge embedded in knowledge workers' personal folders is circulated from peer to peer to facilitate knowledge sharing.

II. 1 Methods Based on Content-Based Filtering

Based on the concept of content-based filtering recommendation, we divide this methodology into three phases. Phase 1 is profile generation; phase 2 is document filtering; and the last phase is recommendation list generation.

In phase 1, the method generates three kinds of profiles, including Document Profile (DP), Category Profile (CP) and User Profile (UP).

Document Profile (DP)

Let d_j be a document, and let $DP_j = \langle dt_{1,j}, dw_{1,j}, dt_{2,j}, dw_{2,j}, \dots, dt_{n,j}, dw_{n,j} \rangle$ be the feature vector (document profile) of d_j where $dw_{i,j}$ is the weight of a term i that occurs in d_j . Notably, the weight of a term represents its degree of importance to represent the document (codified knowledge). The well-known *tf-idf* approach is often adopted for term weighting [9][10]. Let the term frequency $df_{i,j}$ be the occurrence frequency of term i in d_j , and let the document frequency df_i represent the number of documents that contain term i . The importance of term i to a document d_j is proportional to the term frequency and inversely proportional to the document frequency, which is expressed as Eq. (1).

$$dw_{i,j} = \frac{1}{\sqrt{\sum_i \left(dt_{i,j} \times \left(\log \frac{N}{df_i} + 1 \right) \right)^2}} dt_{i,j} \times \left(\log \frac{N}{df_i} + 1 \right) \quad (1)$$

where N is the total the number of documents and the denominator in the right side of Eq. (1) is a normalization factor to normalize the weight of term.

Category Classifier (CC)

A classifier for a category is constructed through *tf-idf* approach which is employed to extract the discriminating terms and their weights among categories of a knowledge worker. Let $CC_r = \langle cct_{1,r}, ccw_{1,r}, cct_{2,r}, ccw_{2,r}, \dots, cct_{n,r}, ccw_{n,r} \rangle$ be the category classifier of c_r where $ccw_{i,r}$ is the weight of a term i that occurs in CC_r . Let the term frequency $ctf_{i,r}$ be the occurrence frequency of term i in c_r , and let the category frequency cf_i represent the number of categories in target user u that contain term i . The weight of term i in a category c_r is proportional to the term frequency and inversely proportional to the category frequency, which is expressed as Eq. (2).

$$cw_{i,r} = \frac{1}{\sqrt{\sum_i \left(ctf_{i,r} \times \left(\log \frac{L_u}{cf_i} + 1 \right) \right)^2}} ctf_{i,r} \times \left(\log \frac{L_u}{cf_i} + 1 \right) \quad (2)$$

where L_u is the total the number of categories in user u . Notably, the denominator in the right side of Eq. (2) is a normalization factor to normalize the weight of term.

User Profile (UP)

The profile of a user u_x is represented as a feature vector of weighted terms derived by analyzing documentation set owned by u_x . After the documents are pre-processed and represented in the form of term vectors, UP_x is derived by averaging the feature vectors (i.e. centroid approach) of documents in u_x . Let D_x denote the set of documents in u_x . Furthermore, the user profile (feature vector) UP_x of user u_x

is defined as the centroid vector obtained by averaging the feature vectors of documents in D_x . Let $uw_{i,x}$ denote the weight of a term i in UP_x . $uw_{i,x}$ is derived as Eq. (3).

$$uw_{i,x} = \frac{1}{|D_x|} \sum_{d_j \in D_x} dw_{ij} \quad (3)$$

Phase 2 applies recommendation scheme to filtering documents of low similarity. Content-based recommendation mainly computes the similarity between category classifier and document profile.

The cosine formula is a widely adopted scheme to measure the similarity degree between two items x and y . The cosine of the angle between their corresponding feature vectors Q and R is computed as given by Eq. (4). The degree of similarity is higher if the cosine similarity is close to 1.0.

$$\text{sim}(x, y) = \cosine(Q, R) = \frac{Q \bullet R}{\|Q\| \|R\|} \quad (4)$$

The method considers both the similarity of document profile to the category classifier and user profile. The predicted rating $\hat{p}_{a,j}$ of recommending document d_j to the category c_a of the target user u_x is expressed in Eq. (5):

$$\hat{p}_{a,j} = (1 - \alpha_{CBF}) \text{Sim}(CC_a, DP_j) + \alpha_{CBF} \text{Sim}(UP_x, DP_j) \quad (5)$$

where $\text{sim}(CC_a, DP_j)$ is the similarity of CC_a and DP_j and $\text{sim}(UP_x, DP_j)$ is the similarity of UP_x and DP_j (u_x is the owner of C_a). α_{CBF} ranges from 0 to 1 and will be decided by the analytical experiments.

The last phase is to generate a recommendation list of document-category pairs for allocating documents to destination categories. The document-category pairs are sorted according to their predicted ratings. The pairs with top-N highest rating are selected for recommendation. Notably, those documents that the target user already has are not included in the recommendation list.

II. 2 Methods Based on Collaborative Filtering

This method uses the opinions of other knowledge workers with similar profiles to make recommendations. Two approaches are developed including Collaborative Filtering (CF) and Collaborative Filtering based on Joint coefficient (CF-J).

II .2. 1 Collaborative Filtering (CF)

There are also three phases in the proposed CF approach. Phase 1 generates the needed profiles. The category classifier is mainly used to determine which category a document should be allocated to, and thus is suitable for classification purpose. However category classifier is not suitable to derive similar neighbors, since the discriminating terms may distort the similarity of categories in different

users. Thus, category profile is defined to compute the similarity of categories, and is further used to find category neighbors. Similar to the generation of user profiles described in section 2.1, the centroid approach is used to derive the category profile.

The profile of a category c_a is derived by analyzing the set of documents in c_a . Each document d_j is pre-processed and represented as a feature vector DP_j . Let D_a denote the set of documents in c_a . Furthermore, the category profile CP_a of category c_a is defined as the centroid vector obtained by averaging the feature vectors of documents in c_a . Let $cw_{i,a}$ denote the weight of a term i in CP_a . $cw_{i,a}$ is derived as Eq. (6). Notably, category profile does not consider the effect of terms in discriminating the category of a user.

$$cw_{i,a} = \frac{1}{|D_a|} \sum_{d_j \in D_a} dw_{ij} \quad (6)$$

Phase 2 identifies the neighbors of the target category. The similarity between CP_s is derived to decide neighbors. For recommending a document d_j to the target category c_a , the neighboring categories (neighbors) of c_a is selected from categories that contain d_j . The cosine formula is used to determine the similarity of CP_s . We use the k-NN based method for choosing neighbors.

Phase 3 derives the predicted rating of document-category allocation. In addition to the profiles, the CDR (Category-Document-rating) / UDR (User-Document-rating) matrix is needed to record the rating of categories/users on documents.

There are two approaches to derive the ratings, binary approach and profiling approach. The binary approach derives the ratings based on the criteria whether the category/user contain the document. If a category c_a contains a document d_j , the rating value of c_a on d_j , $CDR_{a,j}$, is 1; otherwise, the value is 0. If the category c_a is owned by the user u_x , i.e., u_x has document d_j , the rating value of u_x on d_j , $UDR_{x,j}$, is 1; otherwise, the value is 0. The profiling approach uses the similarity of category/user profile and document profile to derive the rating. The rating value of c_a on d_j , $CDR_{a,j}$, equals $\text{sim}(CP_a, DP_j)$, i.e., the similarity of the category profile of c_a and the document profile of d_j . The rating value of u_x on d_j , $UDR_{u,j}$, is set to $\text{sim}(UP_x, DP_j)$, i.e., the similarity of the user profile of u_x and the document profile of d_j .

The CDR/UDR generated by the binary approach is called binary CDR/UDR, while the CDR/UDR generated by the profiling approach is called non-binary CDR/UDR. Eq. (7) computes the predicted rating of recommending document d_j to the category c_a of the target user u_x .

$$\hat{p}_{a,j} = \frac{\sum_{c_b \in c_a's \text{ neighbor}} (1 - \alpha_{CF}) \text{Sim}(CP_a, CP_b) \times CDR_{b,j} + \alpha_{CF} \text{Sim}(UP_x, UP_y) \times UDR_{y,j}}{\text{Number of } c_a's \text{ neighbors}} \quad (7)$$

where $\text{sim}(UP_x, UP_y)$ is the similarity between UP_x and

$UP_y, sim(CP_a, CP_b)$ is the similarity between CP_a and CP_b , c_b belongs to c_a 's neighbors, u_y is the owner of C_b . $CDR_{b,j}$ is defined in phase 3. α_{cf} is a parameter to adjust the relative importance of category similarity and user similarity.

Finally, the scheme generates a list of candidate document-category allocation. The procedure is the same as the CBF described in phase 3 of section 2.1.

II. 2 Collaborative Filtering Based on Joint coefficient (CF-J)

CF-J is similar to CF. The difference between CF and CF-J is the similarity computation. CF calculates the similarity by weighted term profiles. The joint coefficient approach (CF-J) calculates the similarity based on the joint coefficient, which represents the relationship between two categories/users decided by the number of the documents they have in common. The more they have, the more similar they are. Equation (8) is the formula to compute the joint coefficient ($Jcof$) in CF-J.

$$Jcof(c_a, c_b) = \frac{2 \times N_{a \cap b}}{N_a + N_b} \quad (8)$$

where N_a and N_b is the number of documents in c_a and c_b respectively, and $N_{a \cap b}$ represents the intersection of documents that both c_a and c_b have. The binary CDR is used to derive N_a , N_b and $N_{a \cap b}$. Similarly, joint coefficient between two users u_x and u_y can be defined as $Jcof(u_x, u_y)$.

CF-J uses joint coefficient instead of profile similarity to derive the predicted rating as expressed in Eq. (9).

$$P_{a,j} = \frac{\sum_{c_b \in c_a's \text{ neighbor}} (1 - \alpha_{CF-J}) Jcof(c_a, c_b) \times CDR_{b,j} + \alpha_{CF-J} Jcof(u_x, u_y) \times UDR_{y,j}}{\text{Number of } c_a's \text{ neighbors}} \quad (9)$$

III. Experiemnt and Evaluation

Experiments using a real application domain were carried out for recommending research papers in a research institute laboratory.

III. 1 Experimental Setup

Knowledge workers have their own folders storing documents (research papers) that assist them in writing theses or accomplishing research projects. There are 11 users, 35 categories and 1062 documents. The sparsity in the data sets is 99.96%. For each category, there are at least ten documents in order to provide enough information of the codified profiles. We also limit the level of categories to be

one. Those categories with level higher than one will be aggregated into their level-1 ancestors. The data set was divided into an 80% training set and a 20% testing set. The training set includes documents stored in workers' personal folders, and was used to generate recommendation list. Testing data was used to verify the recommendation quality of various methods.

Two metrics, precision and recall, are commonly used to measure the quality of recommendation. These two metrics are also extensively used measures in information retrieval [10]. Recall is the fraction of relevant documents that can be located.

$$\text{Recall} = \frac{\text{number of correctly recommended documents}}{\text{number of relevant documents}} \quad (10)$$

Precision is the fraction of recommended documents (predicted to be relevant) that are really relevant to workers.

$$\text{Precision} = \frac{\text{number of correctly recommended documents}}{\text{number of recommended documents}} \quad (11)$$

Documents relevant to a worker u are those documents owned by u in the test set. Each relevant document is associated with its corresponding category owned by u . Such relevant document with associated category is called a relevant document-category pair of u . Correctly-recommended documents are those in the recommended document-category pairs that match the relevant document-category pairs of u .

F1-metric can be used to balance the trade-off between precision and recall [10]. F1-metric assigns equal weight to precision and recall, and is given by,

$$F1 = \frac{2 \times \text{Recall} \times \text{Precision}}{\text{Recall} + \text{Precision}} \quad (12)$$

III. 2 Experimental result

We compare different factor of CF. CF-Binary, CF-Profile and CF-J uses binary ratings, profiling ratings and joint coefficient, respectively, as described in section 2.2. The $\alpha_{CF} / \alpha_{CF-J}$ is used to tune the weight of predicted rating contributed from Category similarity and user similarity. The α values for CF-Binary, CF-Profile and CF-J, are 0.5, 0.0 and 0.2, respectively, which are decided according to the highest average value. Fig. 2 shows the comparison (F1-metric) of CFs under different Top-N. CF-Binary is relatively better than the CF-Profile method. This indicates that the rating part in the CF-Profile approach does not provide useful rating information by using the profiling approach. The failure of CF-Profile might result from the rating part of formula (the similarity of category and document) which could not truly represent user's rating on the documents. Therefore, the CF-Profile method could not effectively recommend the right document to the right category. Consequently, we adopt the CF-Binary method rather than the CF-Profile Method to represent the CF

method in further comparisons.

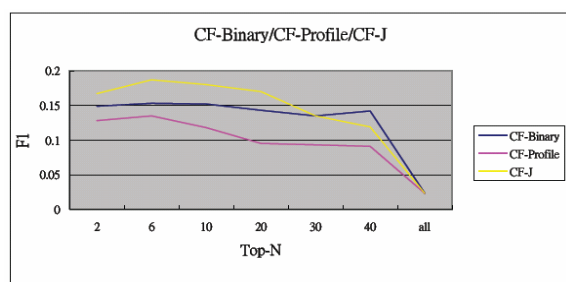


FIG. 2: Comparison of CF and CF-J under different Top-N

Fig. 2 also shows that CF-J achieves better result in smaller Top-N and CF-Binary works better in larger Top-N. The number of overlapped documents among different categories is usually small. Hence, CF-J performs worse when recommending more documents. α_{CF-J} and α_{CF} are set to 0.2 and 0.5, respectively. This indicates that the opinions from the similarity of user profiles provide constructive effect in improving recommendation quality.

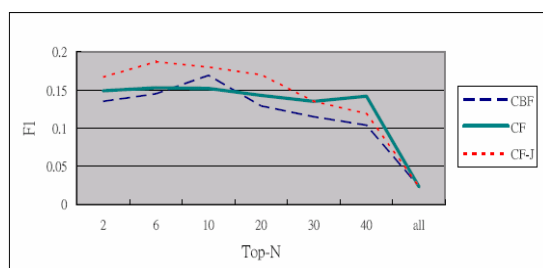


FIG. 3: Comparison of CBF and CF methods

Fig. 3 shows the comparison of CBF, CF (CF-Binary) and CF-J under different Top-N. The CBF uses Category Classifier (CC) to provide content-based filtering. α_{CBF} is set to 0 for CBF. The result shows that the CF and CF-J performs better than CBF. CF-J gain better performance when Top-N is smaller; however, when Top-N is getting larger, CF (CF-Binary) method provides better recommendation quality.

IV. Conclusions

This work investigates the issue of sharing codified knowledge stored in workers' personal folders. Various

recommendation approaches are proposed to recommend codified knowledge to the right category of workers' personal folders. The proposed approach provides workers needed relevant documents from other workers' folders to facilitate knowledge sharing. The explicit codified knowledge can circulate around the organizations by sharing codified knowledge from personal folders. The proposed work can reduce the efforts and manpower in document classification and improve knowledge sharing among organizations.

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Application of Knowledge Management in Organizational Management

Seyed Kamal Vaezi, Ph.D.
Iran's Ministry of Sciences, Research and Technology
vaezi_ka@yahoo.com

Abstract: In fact, any task that uses and applies knowledge can benefit from the structure of knowledge management, and that covers most managerial and professional activities. Therefore, like other management 'fads' before, many existing business practices (such as information management and intelligence gathering) are coming under the knowledge management umbrella. Similarly, information systems solutions, such as document management and data warehousing are being similarly relabeled.

Structurally, the use and sharing of knowledge must be aligned with all of the factors described in the paper. The development and application of knowledge must be relevant and in context to the business direction and the stakeholders needs. Optimum knowledge application, sharing, and flow is only delivered as part of the business processes of the organization. The objectives and measures of each must be common. Most importantly, knowledge growth and use must be specifically tied to the individual and team objective setting, incentive and reward mechanisms of the organization.

Keywords: Knowledge Management, Organization, Innovation Cycle

I. Introduction

Today knowledge is accepted as an important basis for competitive advantages and many organizations are beginning to establish knowledge management systems. Within the last few years many organization tried to design a suitable knowledge management system and many of them were successful.

Managing an organization's knowledge is the latest pursuit of those seeking competitive advantage. The interest in knowledge management has surged during the last few years, with a growing number of researches publications, conferences and investment in knowledge management initiatives.(skyrme,2000)

There are numerous definitions of knowledge management. Knowledge management or KM is an integrated ,systematic approach to recognize, manage and share all of the department's information resources, including databases, documents, strategies, policies and procedures .In this process management creates a new environment where knowledge and experience can easily be shared and also enables information and knowto emerge and

flow to the right people at the right time so they can act more efficiently and effectively.(smith,2001) Briefly KM is "the explicit and systematic management of vital knowledge and its associated processes of creating, gathering, organizing, diffusion, use and exploitation, in pursuit of organizational objectives."(Skyrme.2000)

There are many types and forms of knowledge e.g. facts, know-how, specific skills, procedural knowledge etc. A common interpretation is that of a knowledge hierarchy that goes from data (facts and figures) to information (data with context) to knowledge (information with meaning) to wisdom or intelligence (knowledge with insight). (see figure 1)

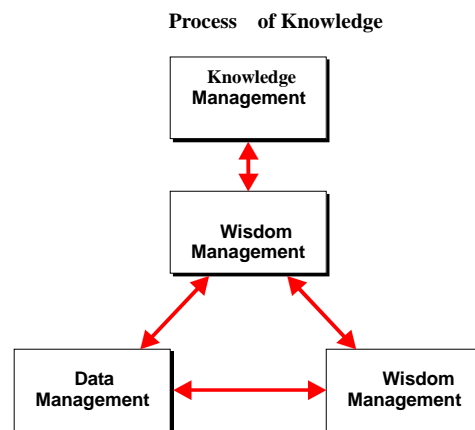


Figure 1

Today knowledge management is accepted as a decisive quality in most developed organizations. The know-how and expertise of the work-force is an important factor for the success of companies and strongly influences the effectiveness and efficiency of the business processes and their development. The concept of Knowledge Management (KM) receives high strategic consideration across multiple sectors. In the management area, KM is specifically relevant due to the knowledge of the the new product development process, which is especially interested in learning from the lessons of the past.(Thoben,2000)

The range of knowledge management activities is extensive, and touches many aspects of organization operations, for example (see figure 2) Creation of knowledge databanks – finding best tasks and expert directories, understanding market intelligence, Application of efficient and Effective information management systems for gathering, censoring, filtering, classifying and storing of information, Creation of knowledge into business processes e.g. through the use of

help screens in computer procedures or access to experts from icons.

Development of knowledge centers - focal points for knowledge skills and facilitating knowledge flow ,Reuse of knowledge at customer support centers e.g. via case-based reasoning, Usage of collaborative technologies, especially intranets or groupware, for rapid information access, Creation of Knowledge webs - networks of experts who collaborate across and beyond an organization's functional and geographic boundaries.(Skyrme,2000)

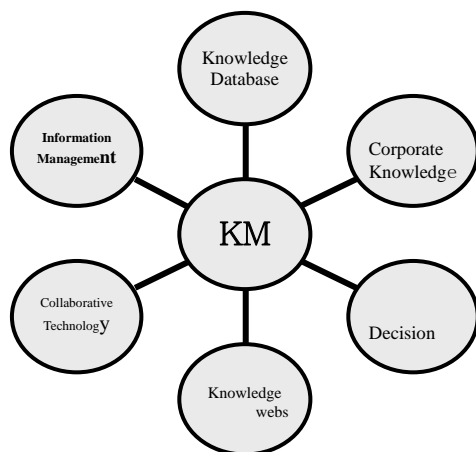


Figure 2 Range of Knowledge Management

Despite the rapid development of KM , most managers believe that much has still to be accomplished. A typical evolution of knowledge management within an organization goes through several phases.(skyrme,2000)

Informal: knowledge management is being practiced to some level in some parts of the organization (although it may not be recognized as such or called 'knowledge management') but formal knowledge management is recognized as a formal project or programme

Then is the time for expansion of the knowledge by using of knowledge management as a regulation grows in practice across different parts of the organization.

Also there is a degree of co-ordination of knowledge management activity; knowledge can be more easily shared across departmental boundaries by a good organizing.

Incorporated knowledge are formal standards and approaches that gives every employee access to most organizational knowledge through common interfaces And finally we can implant the KM. Knowledge management is part-and-parcel of any tasks; it blends impeccably into the background.(see figure 2)

KM Processes

The Knowledge of organization can develop in two primary ways: improve the processes of having knowledgeable people and develop the processes of sharing knowledge among them.(burlton,1998)

Individual knowledge is an skill improved with use, not

consumed when applied, nor lost when transferred, a vital challenge is to attract and retain knowledgeable and motivated personnel. These sentiments are often echoed in service based organizations yet when the state of the processes which are supposed to deliver these is examined we usually find fragmented conflicting practices at best. One way to start to deal with the challenge is to improve the processes which hire staff, align incentives with the business outcomes of value, recognize and payment, train, develop human potential, provide varied experience, and support staff to share experience. The same is generally true for acquiring knowledge from the outside through partnerships, hiring of consultants, research consortia etc. If these supposed enabling processes do not deliver appropriate enablers then knowledge will not translate to action. The objective is to enhance our ability to perform. Performing is a subsequent act.

On the other hand For creation corporate knowledge Organizational size is a major factor in KM programs. Size matters since the larger the organization, the more potential knowledge exists but at the same time the harder it is to identify its source and get access to it with a trust relationship among the potential collaborators. The development and application of knowledge must be relevant and in context to the business direction and the stakeholders needs. Optimum knowledge application, sharing, and flow is only delivered as part of the business processes of the organization. The objectives and methods of each must be common. Most importantly, knowledge growth and use must be specifically coupled to the individual and team objective setting, incentive and reward mechanisms of the task The development and application of knowledge must be relevant and in context to the business direction and the stakeholders needs. Optimum knowledge application, sharing, and flow is only delivered as part of the business processes of the organization. The objectives and measures of each must be common. Most importantly, knowledge growth and use must be specifically tied to the individual and team objective setting, incentive and reward mechanisms of the enterprise. The development and application of knowledge must be relevant and in context to the business direction and the stakeholders needs. Optimum knowledge application, sharing, and flow is only delivered as part of the business processes of the organization. The objectives and measures of each must be common. Most importantly, knowledge growth and use must be specifically tied to the individual and team objective setting, incentive and reward mechanisms of the enterprise. The development and application of knowledge must be relevant and in context to the business direction and the stakeholders needs. Optimum knowledge application, sharing, and flow is only delivered as part of the business processes of the organization. The objectives and measures of each must be common. Most importantly, knowledge growth and use must be specifically tied to the individual and team objective setting, incentive and reward mechanisms of the enterprise optimize the knowledge richness/ease of access dilemma.

In larger organizations, especially, process becomes critical and advanced process renewal aims to optimize knowledge flow for example time to market of new product ideas is a important factor in fast moving industries such as electronics, telecommunications and banking. This procedure must exploit knowledge effectively and efficiently and it must not drag or fail. Processes which embed knowledge in other processes or enablers are paramount. They must generate, collect, structure, store, and distribute and share or stagnation will set in. Collaborative workflow processes which require a well defined flow of activity from knowledge worker to knowledge worker must have well designed connective tissue. Collaborative workgroup processes which require shared research, design and development must have the mechanisms for ongoing sharing of interim and unproven results without professional fear or suspicion. Official and unofficial teams must have shared measures and incentives.

The processes and needs for good individual and corporate knowledge assume that a number of factors are in place which will ensure that the knowledge market operates successfully. Mainly, corporate knowledge requires individual knowledge, the mechanisms and opportunities for sharing, reasons for sharing and individual actions around knowledge to be driving towards the same solutions and outcomes as the business processes.

It is significant that all member of organizations understand what they know and don't know. They must also realize when they should collaborate and when they know enough to simply act. They must be aware of what knowledge exists and who has it or access to getting it. They must also understand why they are doing what they are and what makes an appropriate result.

All individuals must have the ability to identify and get connected to the sources of better knowledge when they need to collaborate or get help. They will require access to those who know in either personal and/or electronic forms. They will require the time availability and organizational authorization from all parties in the collaboration as well as their management. They will also require access to suitable repositories of best practices and guides through effective equipments.

Those involved with knowledge sharing or transfer must first have the personal dedication to improve their own knowledge. This may be through personal learning and training, learning on the job or exploiting opportunities provided through business programs. Whether buyers, sellers or brokers, they must sense openness to sharing with others. They must also truly believe that a trust culture is in place which will encourage communication and sharing rather than punish those who expose themselves. There must also be incentives and rewards to use or share knowledge which are in synch with the incentives and time availability of others. There must be a win-win view of support for all. They must want to share.

II. Application of KM Techniques

However, today's practice in KM still lacks from significant drawbacks and the existing knowledge is captured and capitalised only to a small degree. The reasons for this are manifold, and one of the most critical factors is time. Though many employees are willing to document and utilise existing knowledge, they do not have the time to do this in the pressure of day-to-day business life. Consequently, there is a strong need for methods and tools with utmost user friendliness for rapid Knowledge Management (Thoben, 2000)

In practice, knowledge management is the deployment of a set of tools and techniques that are used to help organizations manage the two knowledge cycles :Innovation cycles and knowledge sharing cycles .In innovation cycle we talk about creating ,codifying ,embedding and diffusing of the knowledge in the organization and in knowledge sharing cycle we focus on identifying, gathering, organizing ,sharing ,learning, applying and evaluating of knowledge in the organization.

In innovation cycle (see figure 3)in the first step we try to create and exist the knowledge by using creativity techniques of structured problem solving ,Creative abrasion: where people form different perspectives discuss ideas, business simulations and models to provide new insights as to how things works, Skilful dialogue to reveal assumptions and to surface new ideas and finally Morphological analysis which is a specific approach in which the functions of a product are described and new combinations or alternative sought.

In the second step we must codify the knowledge in our organization by Designing methods and disciplines which have formal approaches for design; these represent knowledge that was once tacit or ad-hoc and has now been systematized, often into computer-based applications. Many such applications have some core algorithms that embody design rules based on past experience. Also we can use PDM (Product Data Management) for storing information about components that go into a complex product (widely used in the aerospace industry).

These Methodologies are particularly relevant to process design or the deign of work activities; a methodology in the form of procures, guidelines and workbooks represents codification of good practice

In the third step we embed the koweledge by Prototyping: initial 'proof of concept' of new knowledge, it can also be the prototyping of computer applications or even documents, Packaging the knowledge which is made explicit and organized into some form of package, such as a document or a software

To embed knowledge into routine activities.

The final stage in this process is an effective marketting for promulgathing new knowledge especially throw E-marketting .(see figure 3)

In knowledge sharing Cycle ,the first step is identifying the knowledge by information audit which is a process of

identifying core knowledge needs ,Knowledge mapping for visual presentation of the structure of knowledge .text mining for identifying core concepts and finally conceptaul mapping for showing relationships between different entities.

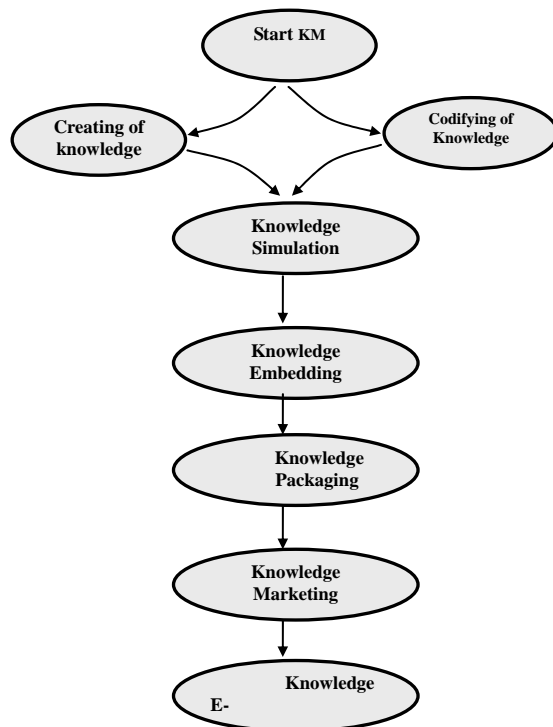


Figure 3 Innovation Cycle of KM

Now is the time for information gathering. We can gather the information by interviewing and also software that searches the internet

After organizing the information by data base systems we cab share the knowledge. For Knowledge sharing we need a knowledge management programme to connect knowledge providers with knowledge users and also to develop and share knowledge around a common vision or common problem. Also we need document management systems to formalize and share explicit knowledge around a key corpus of documents

By cross-functional teams we can also share the knowledge.Teams with people from different disciplines and organizational units; such teams are a good way of sharing knowledge – especially informal knowledge - across normal discipline or organizational boundaries.

Finally we can establish Knowledge centres like the corporate library; a knowledge centre will typically staffed by information scientists (librarians) who act as a conduit between the requester and suppliers of knowledge

In the applying stage we package knowledge by putting knowledge in a form that makes it more widely accessible and support our decision systems.In this process we can also use Case based reasoning (CBR)for

interpreting a situation based on analogues from the past or related situations. CBR is a particular type of artificial intelligence software.

And finally we must Evaluate the knowledge .for this purposes we need KM assessment which is an assessment of activities within a knowledge management programme, gauged against generally accepted good practice and also we need a formal approach for classifying intellectual capital into its components (typically human capital, customer capital, structural capital and intellectual property) and developing metrics to assess how it is changing over time.

At the end we need benchmarking to compare of a specific process with other organizations or units carrying out the same process.(see figure 4)

The above list is used to indicate the many ways in which knowledge management manifests itself within an organization. As the discipline of knowledge management becomes more established, each technique becomes better understood, documented and diffused. Many techniques have associated computer tools that make them easier to implement and diffuse through an organization.

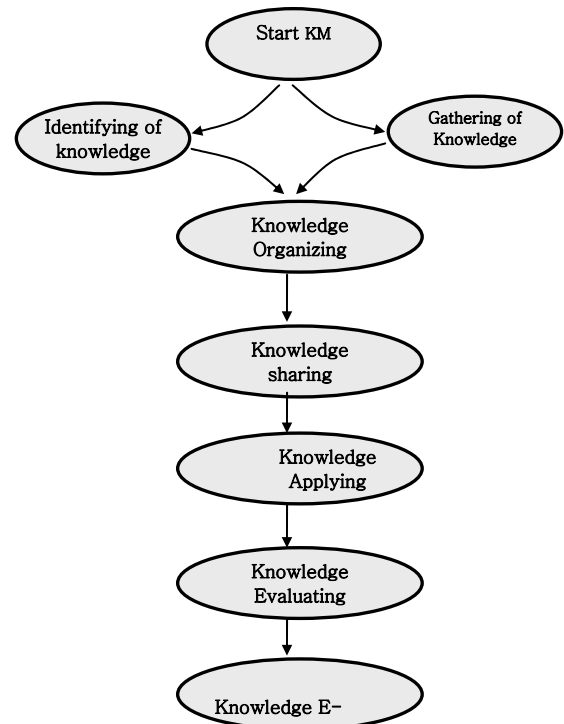


Figure 4 Knowledge Sharing Cycle

III. Conclusion

In fact, any task that uses and applies knowledge can benefit from the structure of knowledge management, and that covers most managerial and professional activities. Therefore, like other management ‘fads’ before, many existing business practices (such as information management and intelligence gathering) are coming under the knowledge

management umbrella. Similarly, information systems solutions, such as document management and data warehousing are being similarly relabeled.

Structurally, the use and sharing of knowledge must be aligned with all of the factors described in the paper. The development and application of knowledge must be relevant and in context to the business direction and the stakeholders needs. Optimum knowledge application, sharing, and flow is only delivered as part of the business processes of the organization. The objectives and measures of each must be common. Most importantly, knowledge growth and use must be specifically tied to the individual and team objective setting, incentive and reward mechanisms of the organization.

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Knowledge Management in Information Technology Help Desk: Past, Present and Future

Nelson K. Y. Leung *, Sim Kim Lau **

* School of Economics and Information Systems

University of Wollongong

Wollongong, NSW, 2522, Australia

Email: kn1164@uow.edu.au, <http://www.uow.edu.au/~kn1164>

** School of Economics and Information Systems

University of Wollongong

Wollongong, NSW, 2522, Australia

Email: simlau@uow.edu.au, <http://www.uow.edu.au/commerce/infosys/lausk.html>

Abstract: Information technology has changed the way organizations function. This resulted in the reliance of help desks to deal with information technology related areas such as hardware, software, and telecommunication. Besides, the adoption of business process reengineering and downsizing have led to the shrinkage of the size of help desk. The shorter information technology product life cycle has worsened the situation by increasing the already sizeable help desk's user base. Consequently, the help desk has to cover more information technology products and resolute more technical enquiries with less staff. Thus, the outcome is clear that users have to wait comparably longer before help desk staff is available to offer assistance. This paper describes the contribution of knowledge management in retaining knowledge and solving "knowledge leaking" problem. The research presents the development of user self-help knowledge management system to re-distribute incoming enquiries so that simple and routine technical enquiries can be resolved without help desk intervention.

Keywords: Knowledge Management, Help Desk.

I. Introduction

Help Desk (HD), also named as computer call centre, contact centre, Information Technology (IT) assist centre or support centre, is an access point to provide IT-related advice, information or troubleshooting action to user. Its responsibilities include first line incident support, day to day communication between IT department and user, business system support and service quality report generating [3, 17]. The widespread application of information technology has resulted in majority of organizational activities to be automated and electronic-based. This trend has led to increase coverage of HD's roles and responsibilities in the organizations. The organizations rely on HD to provide technical assistance on all aspects of information technology related areas such as hardware, software, applications and telecommunication.

The complexity of the business systems has created

infinite number of technical and functional problems. This complexity also means that the users are not able to work at optimal productivity when they are faced with technical problem related to the system. In other words, organization may face potential loss in income, whether direct or indirect, immediate or future. The above situations have resulted in shift of HD's role from a traditional non-profit-making function to an important management asset that plays a vital role to ensure organization-wide Information System (IS) is working accurately and smoothly.

One of the existing challenges for HD is how to manage knowledge in an effective manner. The widely exploitation of IT has significantly increased HD's coverage on software, hardware, network connections and other IT related areas. It is not unusual for a single HD to cover hundreds of thousands of software, hardware, application programs and network connections. Sometimes it is difficult even to memorize all the names of the applications and systems used in the organization. What exacerbate the situation is the adoption of management methodology such as Business Process Reengineering (BPR) and downsizing. This leads to the shrinkage of the sizes of help desks because the overall budget has been reduced. This not only reduced a significant number of experienced HD staff, but also led to the loss of priceless knowledge which is considered to be crucial for the daily operation within the HD boundary. On the other hand, the shorter product life cycle in IT industry makes the predicament even worse. The IT product life cycle accelerates at an unbelievable rate that even a brand new product can be obsolete as soon as it hits the market. As a result, the already sizeable user base covered by the HD and the number of incoming enquiries are increased speedily in direct proportion to the shorter product life cycle. According to a research conducted by the Help Desk Institute, most respondents in the HD industry have said their call volume has been increasing every year in the past ten years [2].

When the HD is expected to cover more IT products and resolute more technical enquiries with less staff. The outcome is clear, the user has to wait comparably longer before the HD staff is available to pick up the call. Heckman and Guskey [12] report that "help unavailable when needed" is the major reason for service delivery failure in HD which in turn leads to user dissatisfaction. Thus, HD is desperate for a method that can deal with the above problems. This

paper discusses the role of Knowledge Management (KM) in HD to overcome the above challenges. This paper also includes the discussion of how generic KM process can be customized within the HD environment by developing a user self-help Knowledge Management System (KMS) as an online self-help tool to improve the support process in the HD.

The rest of paper is organized as follows. Section 2 provides background of KM. Section 3 discusses the evolution of KM in HD. The proposed future of KM within the HD industry is outlined in Section 4. Finally, conclusion is given in Section 5.

II. Background of Knowledge Management

HD experts use both tacit and explicit knowledge to solve user's problem. Tacit knowledge refers to skills, perceptions, assumptions and experiences that reside in the staff's brain whereas explicit knowledge refers to written document, such as technical manual and guide book. KM, a methodology to manipulate tacit and explicit knowledge, has the capability to address "knowledge leaking" problem caused by BPR and downsizing [6, 21, 24]. To examine whether this contribution of KM can be extended to HD, it is critical to review the background of KM.

Back to mid 1980s, tools and techniques such as Total Quality Management (TQM), downsizing and BPR were developed by western companies to aid in re-gaining market share occupied by the Japanese Company. However, both input and improvement are short-termed because these solution approaches are generic and easily available to all rival companies. Once an approach is proven successful, the rival company duplicates and adopts the same practice [23]. The practice of downsizing, BPR and outsourcing, which aims for process optimization as well as cost and time saving, have resulted in loss of many experienced employees along with their capability and knowledge which in turn has "drained" away organization's inspiration and creativity [6]. Thus, organizations have to re-pay high, severe and long-term price in return for transient benefit. The worst is after several years of downsizing and BPR, companies in western world are now competing with each other on equal cost, quality and delivery performance levels. This means that the company has difficulties in differentiating with other challengers. What intensify the already fierce battlefield is the availability of cheap labour in Asian and other developing countries. Thus, the concept of KM is emerged to sustain long term competitive advantage by preserving organizational knowledge [26]. Knowledge is now recognized as one of the most important management assets because knowledge enables organizations to utilize and develop resources, enhance their fundamental competitive ability and develop sustainable competitive advantage [23]. In other words, knowledge allows an organization to do better than rivals.

KM is designed to manage and capitalise on knowledge that accumulates in the workplace [18]. This is achieved by

organizing formal and direct process to create, store and retain knowledge for the benefit of the organization [10, 24]. The entire process of KM (as illustrated in Figure 1) is divided into five stages: create, store, make available, use and evaluate knowledge [4, 27]. There are four methods to create organizational knowledge by means of the interaction between explicit and tacit knowledge [21]. The first method is socialization. It is the process of developing tacit knowledge from tacit knowledge embedded in human or organization through experience sharing, observation and traditional apprenticeship. The second method is called externalization. This is the process of turning tacit knowledge into new explicit knowledge simply by transforming tacit knowledge in the form of document such as manual and report. The third method is combination. This is the process of merging and editing "explicit knowledge from multiple sources" into a new set of more comprehensive and systematic explicit knowledge. The last method is internalization. This is the process of embodying explicit knowledge as tacit knowledge by learning, absorbing and integrating explicit knowledge into individual's tacit knowledge base.

The second and third stages of KM, store and make available, are often linked with technologies. Explicit knowledge created is collected and stored in some form of database or knowledge base in which the users have the right to access by using "search and retrieve" tools, intranets, web access and applications, groupware and so on [1, 22, 24]. Whether knowledge can create value or not, it is directly connected to the fourth stage of KM because knowledge has little value without use [10]. Though the application of knowledge is varied in accordance with business nature, the focus is still on how to make use of knowledge to improve the current value chains. The fifth stage of KM is knowledge evaluation. This phrase eliminates incorrect or outdated knowledge [1]. In other words, organization must keep creating new knowledge and to replace any knowledge that has become invalid [10].

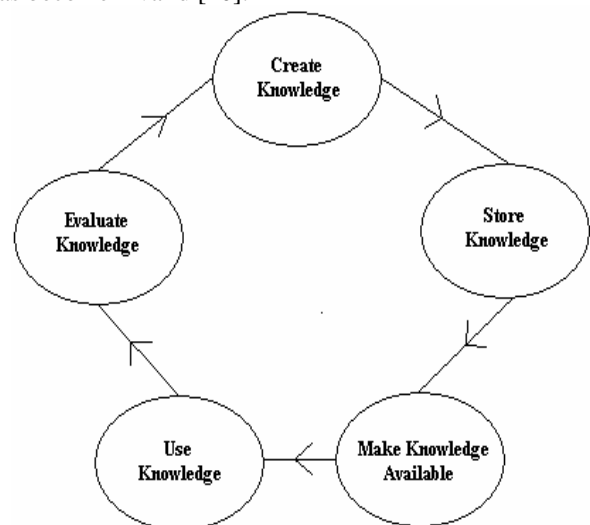


FIGURE 1: The Five Stages of Knowledge Management [4, 27]

III. Evolution of Knowledge Management in Help Desk

Basically, HD composed of HD support staff and technical equipment. Nevertheless, the actual axis of the overall support process in HD is knowledge. When user requires technical support, this means s/he lacks sufficient IT related knowledge to carry on her/his duty. The HD staff is responsible to help to solve the problem by using knowledge resides in some sort of repository, such as human's brain, database or technical manual. One can easily imagine the predicament if HD only contains staff and equipments. When the five stages of KM together with IT are applied to preserve technical knowledge in HD, the combination works perfectly well in preserving HD's knowledge (see in figure 2). The technical knowledge is converted by both externalization and combination. Externalization is used to convert skill, technique, experience and perception from experts into explicit knowledge and combination is used to combine and revise explicit knowledge from manual, guidebook and training documentation into a more systematic and organized knowledge. In this way, both types of knowledge are converted to a form that can be stored in the electronic repository. Structure Query Language (SQL) can be applied to allow the HD staff to retrieve the required knowledge from the repository. More advance techniques such as search engine, agent technology and artificial intelligence can also be applied to retrieve this knowledge. The retrieved knowledge is used to resolve user's problem. The shorter product life cycle in IT also means the knowledge resides in the repository is required to be evaluated regularly in order to maintain its validity. The outdated knowledge is either renewed and stored into the repository or removed permanently from the repository.

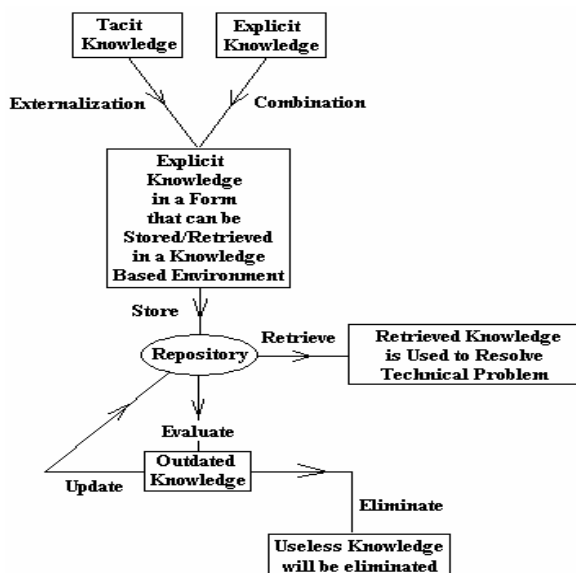


FIGURE 2: The Generic Process of Knowledge Management in Help Desk Environment

These five stages have provided a framework to preserve knowledge in the HD. Undoubtedly, in order to maximize its effect, a certain degree of customization may be required depending on the organizations. Although literature has shown that research has been conducted on the application of KM in HD, most of them are focused on technical aspect of how to store and retrieve knowledge and only a handful covers the entire KM process in HD [5, 7, 8]. To effectively customize the five stages of KM, it is essential to have a thorough understanding on how knowledge is managed along with the evolution of HD. Thus, a brief overview on the development of knowledge handling techniques in the HD is given in the following section.

III. 1 Past and Present

At the early stage, decentralized HD model was very popular. Organizations often have more than one HD in 1980s. Various HDs were established by departments, branches and IT work groups. For example, there were nine different HDs in Western Kentucky University in which user had to determine which HDs to call, depending on where the problem was, what the problem was and when the problem occurred [14]. The decentralized HD model shares the belief that diverse support issues could be referred to related HDs easily so that timely response could be acquired. At that time, each HD had its own collection of training manual, guidebook, technical manual and other paper-based documentations in which computer knowledge was stored and organized. Decentralized HD worked well together with this primeval knowledge handling technique in the very beginning because computer system was simple and straight forward. So it was quite easy for the HD staff to locate the right piece of knowledge from the low-quantity paper-based manuals. On the other hand, the effort required to update the paper-based documentation was light because computer life cycle was relatively longer.

As IT infrastructure grew more complicated and organization-wide information systems were interconnected with a large number of hardware and software, the classification of problem domains became not so distinct. Users became confused with multiple HDs and they were often being directed from one HD to another before obtaining a correct solution. Then, organizations started to adopt centralized HD model [17]. The idea is to merge various HDs into one and user only needs to memorize a single telephone number for all IT related enquiries. This makes HD the first and single point of contact. Nevertheless, the adoption of HD consolidation also challenged the traditional way to manage IT knowledge. Rather than to allow IT knowledge to be scattered in multiple collections of paper-based documentations, centralized HD was required to merge all of them into one. Obviously, the conventional paper-based manipulation method could not afford the sudden burst of knowledge from various HDs. One can easily imagine the clumsiness of the combined paper-based documents. Moreover, IT knowledge, resided in the combined paper-based version, would be extremely hard to

search and update. As long as HD staff realized that electronic repository could provide assistance, they started migrating IT knowledge into computer file system that has the capability to accommodate huge amount of IT expertise. However it has its disadvantage in which there is a lack of flexibility in handling knowledge. Very often a programmer is required to implement complicated programs even in simplest knowledge retrieval and storing tasks. Then the emergence of database technology overcomes the shortcomings in the file system. Database technology not only provides a more structured way to manage knowledge, but the simplicity and easy-to-learn ability of SQL also allow the HD staff to create, store, retrieve, use and review knowledge effectively and efficiently. Because of the about advantages, database technology has assisted the development and standardization of information and knowledge in HD industry.

Expert system is another useful tool to manage IT knowledge, especially on how knowledge is "made available" [26]. Expert system is considered as an appropriate tool in the HD industry due to the characteristics of scarceness, diverseness and expensiveness of expertise [11]. The ever expansion of IT makes the HD staff not able to fully understand and handle the enterprise-wide systems. As a result, it is impossible for the HD staff to offer immediate assistance if one of the experts with a particular knowledge is unavailable. Conversely, HD staff is able to provide recommendation and solution for a routine or even complex problem simply by entering its description and symptoms to the expert system. Then the embedded inference engine will try to find the best diagnostic method from the knowledge base where IT expertise or knowledge is resided. The application of expert system ensures not only the availability of expertise but also minimizes the problem solving duration and cost. However, Middleton [19] argues that expert system and other artificial intelligence related system are not as popular as predicted. Though expert system offers an intelligent method to retrieve knowledge, Czegel [7] points out some shortcomings in the HD expert system. These include high cost and time consuming in knowledge acquisition as well as knowledge base maintenance, high complexity of problem domains, not user friendly and difficulties in system development.

Nowadays, some global corporations with offices all over the world implement another model called distributed or virtual HD model. This model promotes HDs of multiple physical locations. Users can still keep in touch with them by using one contact number through the modern call routing technology [25]. In this way, HD is able to operate twenty-four hours a day, seven days a week regardless of the location. For example, Morgan Stanley, one of the largest investment banks in the world, consists of four HDs in different sites (USA, England, Japan and Hong Kong) which enable them to provide enterprise-wide twenty-four hours HD service. Though distributed HD may only have one electronic knowledge repository that located in one particular office, the innovative data communication

technology allows the HD staff to store, retrieve and update knowledge regardless of geographical and time limitation.

E-support is another innovative support model that is believed to lead to a new revolution in the HD industry in the nearest future; it can be achieved due to its ability to provide better, faster and cheaper service. Broome and Streittwieser [2] specify that all support actions that use internet or web as the primary communication channel should be included as e-support. One of the key stimuli in promoting e-support is the emergence of web-based tools. Users can make use of email or web form to contact the HD ignoring its actual service hours or users can access online resources, such as knowledge base and Frequently Asked Question lists (FAQ), to look for information that is useful to resolve their existing difficulties. Furthermore, the HD staff is capable of conducting web training or using remote control technology to help user to resolve their problems. The concept of e-support breaks through the customary KM border by expanding the third and fourth stages of KM (make knowledge available and use knowledge) to the user.

IV. Proposed Future of Knowledge Management in Help Desk

The five stages of KM have standardized the process of organizing knowledge in the HD. What is more, the combination of KM and database technology enables the HD to manipulate enormous amount of knowledge in a structured way. Both tacit and explicit knowledge are converted in a form that can be stored in knowledge base. The knowledge can later be retrieved and used by HD staff and user. No doubt that KM succeeds in dealing with the loss of knowledge caused by BPR as well as downsizing, but is that all the contribution that KM can make to the HD industry? Nonetheless, the potential of KM is far beyond that: effective customization in KM has the capability to aid HD in going through the existing challenges and enables HD to control the ever increasing user base. The best method to stop the expansion of user base is to slow down the IT product life cycle, but this approach is perceptibly out of HD's control. Moreover, slowing down the IT product life cycle may cripple an organization's profit and competitive advantage. The clue to control user base lies in the composition of the incoming enquiries. Knapp and Woch [15] state that 80% of enquiries request no specialized knowledge. Dawson and Lewis [9] point out that close to 50% of calls to ITS help desk at Deakin University are related to login name and password. Both researches indicate that the majority of incoming technical problems and enquiries are classified as simple and routine. Rather than calling HD, users are capable of solving simple and routine technical problems themselves if sufficient knowledge and guideline are provided. The concept of e-support sustains the idea of transferring part of the troubleshooting duty from the HD to users. When the users have problems, they can solve their problems by searching related solution from online knowledge base or FAQ.

However, online user knowledge base normally shares the same design as the one access by the HD staff. If the knowledge base is designed to support “keywords search” in which users have to locate the most appropriate solutions by entering a few keywords that best describe the problems, users often do not know how to use the right jargons to explain the problems. Although they may successfully use their own words to depict the problems, the “keyword search” may return ten or even more solutions which will deepen users’ frustration. The complexity of the user interface can drive away novice users or even users classified as medium-skilled. Similarly, FAQ is always overlooked by users because its mechanism lacks the ability to support users in dynamic and flexible manners.

IV. 1 Proposed Re-distributed Knowledge Management Model

To ease the overloaded HD, we propose a new mechanism to re-distribute simple and routine enquiries in the KM process within the HD environment. We propose to develop the user self-help KMS as a replacement to the legacy online knowledge base and FAQ in order to improve the support process in the HD.

Let us define the phrase “simple and routine technical enquiries” first. Simple and routine technical enquiries in this paper are referred to technical problems that can be solved by user if adequate relevant information is provided without direct or indirect intervention from the HD staff. These enquiries can be categorized into four types: account and password enquiries, service guidelines, hardware and software enquiries and miscellaneous enquiries. The account enquiries include account setup, termination, maintenance, login problem and suspension, whereas password inquiries include password retrieval, reset, syntax information and password invalid. On the other hand, service guidelines refer to guidelines on hardware installation, software installation, software purchasing, hardware purchasing and service purchasing. The hardware and software enquiries include performance and functional concerns in relation to the hardware and software. The miscellaneous enquiries include queries on missing and corrupted files, unreachable website and server plus their performances.

The above categories may need to vary depending on the types of software and hardware, users, users’ skill sets and business processes. To identify routine and simple enquiries, we propose to use the reports generated by the HD Management System and the Automatic Call Distribution System (ACD). These reports provide data and information on problem type, resolution method, call duration (time required to solve the problem) and so on. By inspecting the reports in a regular manner, the HD manager can work out which enquiries are routine and simple. For example, the HD management report may have indicated that there were many enquiries about “email login failure” in which most of them were related to “password invalid” and the required resolution method was merely to “reset password”. Thus by matching the above information with call duration in the

ACD report, the HD manager could confirm the enquiries as simple and routine because the duration for each call was short. However, the advice of the HD staff can never be overlooked. Hence the classifications of the enquiries that have been deduced by the HD manager must be verified by the HD staff to ensure the accuracy. The proposed mechanism of identifying simple and routine enquiries is illustrated in figure 3.

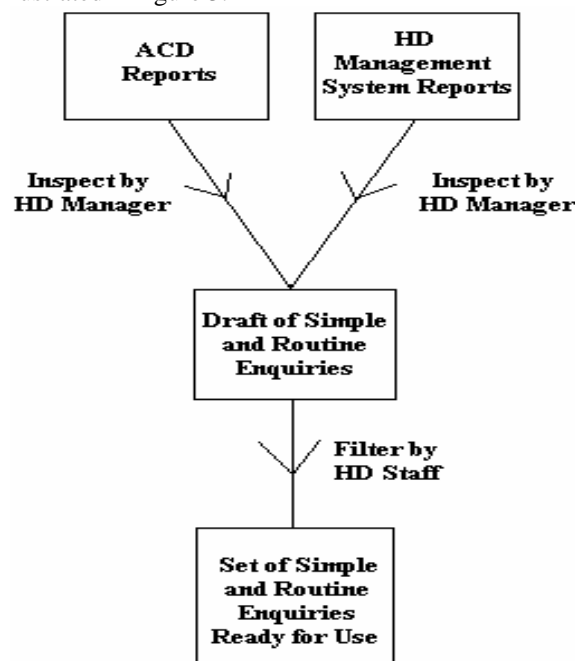


FIGURE 3: Proposed Mechanism to Identify Simple and Routine Technical Enquiries.

To effectively re-distribute simple and routine technical enquiries, the proposed mechanism will be added to the generic KM process and the resulting model is shown in figure 4. Rather than storing explicit knowledge into repository straight a way after externalization and combination, the proposed mechanism will be applied between these two steps, with the aim to distinguish the knowledge into two categories: 1) simple and routine and 2) complex. While simple and routine knowledge is stored in the proposed user self-help KMS, the complex one is resided in the general knowledge repository. Consequently, user can first access the proposed user self-help KMS and look for the most appropriate solution in accordance with the associated IT problems. Only if the solution is not available in the proposed self-help KMS, then the user will contact the HD for assistance. The repository where complex IT knowledge is resided, will be used by the HD staff to answer complicated technical enquiries. This model also allows the proposed system to be tailor-made in accordance with user’s skill sets. Because IT knowledge often contains a lot of technical terms and jargons, the HD staff can rephrase and simplify the resolutions that store in the self-help KMS to ensure users can understand the resolution methods.

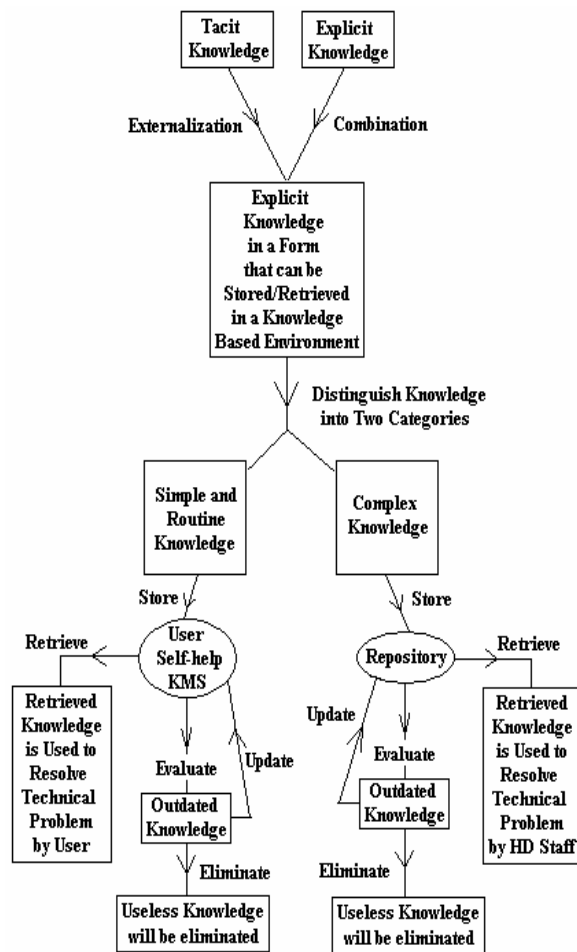


Figure 4: Proposed Re-Distributed Knowledge Management Model in HD

The basic architecture of the proposed user self-help KMS is shown in figure 5. There are five basic components within the architecture: user's browser, two software agents (interface and search agent), resolution knowledge base that stores solutions for simple and routine enquiries and the interface database that stores information required to facilitate user communication. Software agent is a computer program that behaves like human and is capable of autonomous actions in pursuit of specific goal [16, 20]. Software agent technology can be used to free user from onerous search duty by dedicating itself to look for the most suitable solution in the extensive knowledge base based on user's requirement. Moreover, it is also capable of facilitating user communication and description of problems.

Though traditional programming approach is able to develop a similar system, using software agent approach to develop the proposed user self-help KMS tends to: 1) be more natural in depicting and modeling the complexity reality, 2) reduce problems associated with coupling of components, and 3) reduce difficulties associated with managing relationship between software components [13]. In practice, systems developer can customize the system based on the actual needs of both users and the organizations

by inserting different attributes into software agents. Examples of agent characteristics include autonomy, reactivity, proactiveness, collaborativeness, mobility, adaptability, personality, temporal continuity, communication ability, flexibility, learning ability and intelligence [13, 16, 20]. The agent approach also minimizes the re-programming effort for system updating and maintenance because adding, converting, removing or replacing an agent is relatively easier than any other existing approach [13]. The unique characteristics in software agent technology enable the HD to customize its own user self-help KMS based on this architecture. This architecture can be modified to suit different HD's criteria: 1) by adding extra software agent, 2) by removing software agent, 3) by inserting additional attributes into software agent and 4) by removing existing attributes from software agent. For example, if it is decided that additional feature in which the user can choose to conduct an online consultation with the HD staff (in case the user cannot find any suitable solution), then the system can add an additional communication agent which possesses the ability to facilitate online consultation. This type of customization is straightforward and does not require major changes to the system.

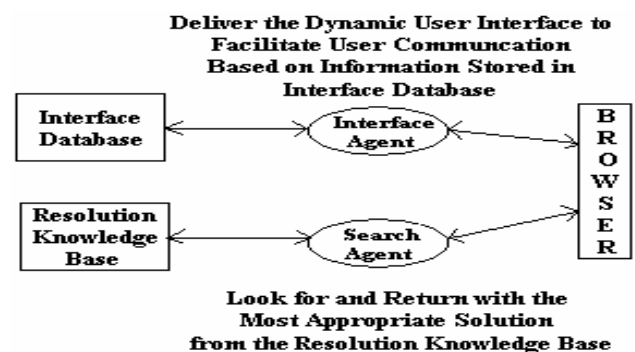


FIGURE 5: Proposed Architecture of User Self-Help KMS

The proposed user self-help KMS also makes use of modern web technology as a mean to deliver the system. The system is delivered by internet and appeared on the browser to facilitate the interaction with user and delivering user request for resolution. The following steps describe how the system will be deployed.

- To activate the system, the user simply clicks on the target URL. Subsequently, the interface agent that possesses communication capability will deliver a dynamic user interface to the browser, based on the information stored in the interface database. The dynamic and interactive communication capabilities of the interface agent provide an "easy to use" user interface in helping user to present and identify the problems. A simple implementation of dynamic user interface is shown in figure 6. Firstly the interface agent interacts with user by asking user to select a problem type on the user interface. Based on the input, the

interface agent will generate the next category of possible problem scenarios. This type of interaction will continue until the agent has gathered sufficient information to process the query.

- When the problem is described through the deployment of the interface agent, the search agent will be deployed to search for possible solutions. The search agent which possesses “the ability to act autonomy” is responsible for this task. Here, “the ability to act autonomy” refers to the capability of an agent to perform its task without direct control from the user or with only minimum supervision and direction. To achieve the preset goal of finding the most appropriate resolution, the search agent will be deployed as soon as the agent is able to “sense” sufficient information has been gathered. The search agent will then examine the contents in the knowledge base, make its own decision to select a solution according to user’s problem description and return the solution to the user.

The figure illustrates a dynamic user interface process through four sequential steps, connected by downward arrows:

- Step 1:** A form with the label "Please select a Problem Type:" and an empty dropdown menu.
- Step 2:** The dropdown menu is populated with two options: "Hardware" and "Software".
- Step 3:** "Hardware" is selected in the first dropdown. A second dropdown, labeled "Please select from the following Hardware:", is shown with a list of hardware items: Printer, Monitor, Mouse, Keyboard, Scanner, Speaker, Phone Headset, and Phone Handset.
- Step 4:** "Hardware" remains selected in the first dropdown. "Printer" is selected in the second dropdown. A third dropdown, labeled "Is it a Functional Enquire or Technical Problem?", is shown with two options: "Functional Problem" and "Technical Problem".

FIGURE 6: Simple Implementation of Dynamic User Interface

V. Conclusions

The generic KM process enables HD to create, store, make available, use and evaluate both tacit and explicit knowledge.

These five stages not only allow HD to manipulate enormous amount of knowledge, they also solve the problem of knowledge loss associated with BPR and downsizing. By adding the proposed simple and routine technical enquiries identifying mechanism and user self-help KMS to the generic KM process, simple and routine technical enquiries are re-distributed in a way that users can look for their own solutions instead of calling HD. Since a sizeable amount of enquiries are now re-routed to the user self-help KMS, HD staff can be freed up to handle high level support issues, to participate in proactive support activities and to attend regular trainings. From the user perspective, rather than waiting in a long queue for a simple resolution, user can look for the most appropriate solution simply by using the system regardless of time and geographical restrictions. Alternatively, for those who have complicated enquiries, the waiting and troubleshooting durations will now be shorter because more staff are available and fewer users are in the queue. This means the user can now enjoy a better, quicker and more direct service. Economically speaking, the user self-help KMS is an extremely cost-effective support method because the average cost for a web self-help transaction is four hundred times less than a telephone transaction and eighty times less than an email transaction [2]. Finally, the potential to convert the radical habit in user's dependence upon the HD as well as promote self-learning atmosphere cannot be overlooked as an old Chinese proverb says "Give a man a fish and you feed him for a day. Teach a man to fish and you feed him for a lifetime."

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An Empirical Assessment of the Performance Impacts of IS Support for Knowledge Management

Michael J. Zhang
Sacred Heart University
Fairfield, CT 06825, U.S.A.
Tel: (203) 396-8234
Email: zhangm@sacredheart.edu

Abstract: In this study, the performance impacts of information systems (IS) support for two key knowledge management activities (knowledge creation and knowledge sharing) were assessed with both survey and archival data. The results showed that IS support for knowledge creation and IS support for knowledge sharing had direct positive effects on labor productivity. Coupled with unique, complementary organizational resources, both types of IS support exerted positive effects on profitability.

Keywords: knowledge management, information systems, firm performance, competitive advantage.

I. Introduction

With the widespread recognition of knowledge as a critical source of sustainable competitive advantage (Spender & Grant, 1996), developing and mobilizing value-creating knowledge for competitive advantage and superior economic performance becomes a central issue facing academics and practitioners alike. In the field of IS management, the past decade has witnessed a proliferation of research on IS roles in knowledge management (see Alavi & Leidner (2001) for a review of the related research). While much of the extant literature has identified various ways a firm can use IS to generate and leverage its knowledge resources for improving its competitive position and performance (Gold et al., 2001), it remains unclear whether such IS deployment would actually result in positive economic returns for the firm, due to little empirical evidence linking IS support for knowledge management directly to the bottom-line performance of firms.

Moreover, while IS have traditionally been viewed as one of the key enabling tools for knowledge management, researchers have increasingly entertained the notion that IS alone would not lead to knowledge-based competitive advantage and that other organizational resources need to work in conjunction with IS in order to generate the economic benefits from IS support for knowledge management (Ciborra & Patriota, 1998; Davenport et al., 2001). Unfortunately, discerning the moderating effects of complementary organizational resources on the performance impacts of IS support for knowledge management has received little attention in the extant literature. This study

was undertaken to assess the performance impacts of IS support for two key knowledge management activities: knowledge creation and knowledge sharing. The study also examined and tested the potential moderating effects of certain unique organizational resources that complement the IS support.

II. Theory and Hypotheses

II. 1 IS Support for Knowledge Creation and Firm Performance

While nowadays knowledge (e.g., insights and ideas) is often distinguished from data and information (e.g., facts and numbers) in the literature (Drestke, 1981), it is well recognized that data and information are indispensable to knowledge creation (Kogut & Zander, 1992). The communication and storage capabilities of IS can be used to enhance a firm's ability to collect critical information for creating useful knowledge. The electronic communication capabilities of IS allow the firm to overcome time, geographical and organizational barriers in gathering data and information (Stroud, 1998). The ongoing increases in storage capacities of IS along with automatic capturing, on-line access and user-friendly interface greatly expand the firm's capacity to retain more data with completeness and precision and facilitate information access and retrieval (Huber, 1991). Moreover, expert systems and case-based reasoning systems facilitate the capture and accumulation of valuable and firm-specific expertise and skills (Lado & Zhang, 1998) and extract valuable knowledge from existing databases (Chopoorian et al., 2001).

IS can also be used to enhance a firm's ability to obtain valuable information from external sources in a timely and efficient manner. With online access to various external databases, executive information systems (EIS) enable managers to search and retrieve a large amount of external information in a timely manner (Young & Watson, 1995). Web-based network systems (e.g., extranets) facilitate the collection of information about customers and market trends (Stroud 1998). There is growing empirical evidence that IS support for external information gathering has led to improvements in firm performance. Several field studies of inter-organizational systems have reported faster response to market changes and significant operational efficiencies accruing from IS-enhanced information exchange between firms (Scott, 2000). EIS research has also indicated that IS support for environmental scanning has led to improved

productivity, more successful new product introduction, and improved decision making (Ahituv et al., 1998).

Hypothesis 1: IS support for knowledge creation is positively related to firm performance.

II. 2 IS Support for Knowledge Sharing and Firm Performance

It is evident in the literature that IS can play an important role in the knowledge sharing process. Early studies of the electronic communication systems found that the systems greatly increased the speed and spread of information delivery and supported synchronous communication (Adam et al., 1993). More recent communication systems (e.g., Lotus Notes) and systems with sophisticated search technologies (e.g., semantic network and adaptive pattern recognition processing) foster company-wide exchange of best practices and facilitate the process of matching solutions to problems (Goodman & Darr, 1998). Moreover, video conferencing allows for the transmission of information and knowledge in rich media (Fulk & DeSanctis, 1995). Web-based intranets reduce costs and time in preparing and transferring information in ultra-rich content and promote information sharing across global boundaries (Boudreau et al., 1998). Intranets also facilitate contacts between individuals that seek information and knowledge and those who possess them by supporting electronic bulletin boards, discussion groups and corporate directories (Andreu & Ciborra, 1997). Aside from facilitating internal knowledge sharing, IS allow the firm to share critical information and knowledge with its business partners for economic gains (Scott, 2000).

There is growing evidence that firms may enjoy performance improvements from IS support for information and knowledge transfer. Goodman and Darr (1998) have found that computer-aided systems helped firms increase sales, market share, customer satisfaction and organizational productivity by facilitating the sharing of useful information and expertise in a timely and cost-effective manner. Case studies of IS support for cross-functional sharing and integration of information in both manufacturing and service firms have also documented such operational benefits as improved productivity, reduced lead times and increased flexibility (Goldhar & Lei, 1995). Moreover, research on the organizational benefits of intranets has reported lower communication costs and higher labor productivity associated with the use of intranets (O'Dell & Grayson, 1998). In a recent study, Andersen and Segars (2001) have found a positive impact of IS enhancement of internal communications on the financial performance among large companies.

Hypothesis 2: IS support for knowledge sharing is positively related to firm performance.

II. 3 Moderating Effects of Unique, Complementary Organizational Resources

It is evident from several streams of research that a firm's

organizational culture and structure are instrumental in influencing its ability to derive competitive benefits from IS-enhanced knowledge creation and sharing. Recent research on organizational barriers to knowledge management suggests that firms may not be able to turn data and information into useful knowledge and organizational results from their IS without a supportive organizational culture and structure (Davenport et al., 2001). Even if new knowledge is created from employing IS, sharing the new knowledge may be limited by cultural and structural constrictions (Ciborra & Patriota, 1998). The absence of organizational culture and structure that support the smooth implementation and use of IS has been documented as a major cause of many system failures in the IS implementation and adoption literature (Constant et al., 1996). The business process reengineering research also shows that firms whose structures and processes are not aligned with their new IS have experienced difficulty in reaping the benefits of the IS (Keen, 1993). Aside from affecting the economic impacts of IS-based knowledge creation and sharing, firm-specific organizational culture and structure make it difficult for competitors to imitate the IS they complement because organizational culture and structure tend to be intangible and costly to imitate (Barney, 1986).

A firm's unique competitive scopes (geographic, segment, vertical, and industry) can also affect its ability to effectively use IS for knowledge creation and sharing. For instance, firms with a broad geographical presence and product breadth are in a better position to generate and exchange more expertise among more locations and product lines than those with narrow geographical and product coverage (Feeny & Ives, 1990). Firms can also combine the scale advantage from their unique vertical integration and related diversification with IS to develop and transfer critical skills and expertise from multiple markets for competitive advantage (Clemons & Row, 1991).

Hypothesis 3: The interaction between IS support for knowledge creation and unique, complementary organizational resources is positively related to firm performance.

Hypothesis 4: The interaction between IS support for knowledge sharing and unique, complementary organizational resources is positively related to firm performance.

III. Methods

III. 1 Sample and Data Collection

The data tapping the independent and moderating variables were gathered via a mail survey. The data about the performance and control variables were obtained from the Research Insight database. The target respondents of the survey were senior IS executives in large firms in the U.S. Before mailing the survey instrument to the target respondents, the instrument was pre-tested and refined for content validity and item clarity with CIO from five large companies headquartered in a mid-western state. Of the 778 firms that received the questionnaires, a total of 153 usable

responses were returned (20% response rate).

III. 2 Measures

Based on the above literature review, six items were developed to measure IS support for knowledge creation and five items to measure IS support for knowledge sharing. For each item, the respondents were asked to indicate the extent to which their IS had provided a particular type of support during the previous three years on a five-point, Likert-type scale with anchors ranging from "Very great extent" (=5) to "No extent" (=1). A joint factor analysis of the eleven items revealed two factors explaining about 50% of the total variance and corresponding with IS support for knowledge creation ($\alpha = .80$) and IS support for knowledge sharing ($\alpha = .72$), respectively.

Unique, complementary organizational resources were defined as a set of firm-specific organizational resources that complemented IS support for knowledge creation and IS support for knowledge sharing. In keeping with Feeny and Ives (1990) and Clemons and Row (1991), this measure included unique organizational culture, unique organizational structure, and unique competitive scopes (geographical area, breadth of products, vertical integration, and range of related industries). The respondents were asked to indicate the extent to which the use and implementation of their IS required each of these six resources on a five-point, Likert-type scale with anchors ranging from "Very great extent" (=5) to "No extent" (=1). A factor analysis of the six items revealed a single factor explaining about 50% of the total variance, confirming the unidimensionality of the scale ($\alpha = .80$).

Both profitability and labor productivity were used to assess the performance impacts of IS support for knowledge creation and IS support of knowledge sharing. A popular profitability ratio, return on sales, was chosen to measure profitability. Labor productivity was measured as sales to employees. To smooth annual fluctuations and average out short-term effects, a three-year average was used for both dependent variables. Moreover, six control variables were used to control for industry conditions, firm size, technological resources and organizational slack.

III. 3 Analyses and Results

To test the hypothesized main effects and moderating effects, two sets of hierarchical regression analyses were performed, using ROS and sales to employees as the dependent variables. The results indicate that IS support for knowledge creation and IS support for knowledge sharing were both associated with sales to employees at the .05 significance level. Both variables also interacted with unique, complementary organizational resources in predicting ROS at the .05 significance level.

IV. Conclusion

Contrary to the growing skepticism towards the performance impacts of IS support for knowledge management (Husted &

Michailova, 2002), the findings from this research suggest that IS may represent more than a strategic necessity for knowledge management and that IS support for two critical knowledge management activities can actually lead to superior economic performance. Hence, firms should continue to invest in and deploy IS resources to facilitate the development and sharing of valuable and firm-specific knowledge.

While generally confirming the competitive value of IS support for knowledge management, the moderation results herein reveal that the profitability impacts of the IS support depend on the presence of certain firm-specific, complementary organizational resources. Absence such resources, both types of IS support only influenced labor productivity. Accordingly, it is not sufficient for firms to simply invest in IS to facilitate knowledge creation and knowledge sharing if they expect profitability gains from such IS investments. Firms also need to invest in the development and leveraging of other firm-specific resources that not only facilitate the implementation and exploitation of IS for knowledge creation and knowledge sharing, but also make such IS less susceptible to imitation.

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Knowledge Management in Small and Medium Enterprises: An Australian Study

Jun Xu, Shankar Sankaran, Ben Faranda
Graduate College of Management
Southern Cross University, Australia
Tweed Gold Coast campus, Brett Street, Tweed Heads
PO Box 42, Tweed Heads, NSW 2485, Australia
E-mail: jxu@scu.edu.au

Abstract: This research aims to examine the factors influencing the knowledge management practices in Australian SMEs. Primary data was collected by studying companies in Tweed and Gold Coast areas. Besides the academic contribution to the field of knowledge management, this research will be able to provide applicable and practicable suggestions on the knowledge management practices to SMEs in Australia.

Keywords: Knowledge Management, SMEs, Qualitative Methods, Content Analysis

I. Introduction

As a result of the changing market places (from capital assets market to knowledge economy), competition, and the rapid development of technology, organizations are starting to pay more attention to maximize their knowledge-based assets. More and more organizations are starting to realize that knowledge is their most important asset and the knowledge-related assets will be the base of sustainable competitive advantage and the foundation of success in the 21st century [34]. Organizations are understanding and accepting the fact that the most important source of wealth and basic economic resource in the contemporary society, the “knowledge society” called by Drucker [12], is knowledge and information [31]. When a business faces competitors that perform well in areas such as planning, marketing, products, customer services, structure, organizational resources management, effective management of knowledge may be the only weapon to win the competition [8]. Researchers (such as Drucker [12], Sveiby [29]; Nonaka & Takeuchi [21]; Davenport & Prusak [7], among many others) bring out that knowledge and intellectual capital are an organizations’ primary sources of production and value and tangible assets such as land, plant, equipment are rarely their most valuable assets. Through successful knowledge management, organizations are able to act intelligently to sustain their long-term competitive advantage through developing, building, and deploying its knowledge assets [36].

A lot of research have been done on the knowledge management in large organizations. However the literature on the knowledge management in SMEs is very limited. For

example, only 31 articles could be found on “knowledge management and SMEs” in Proquest 5000 database when a search was made on June 1, 2005. There is a lack of empirical study in the area of knowledge management in SMEs, especially in the Australian context. The only literature on KM in Australian SMEs can be identified is Braun [6], which suggests a conceptual model mapping access to knowledge flows within SMEs. In the mean time, there exists an argument that large organizations in Australia may not be the most innovative sources of knowledge management. Sveiby [28, <http://www.sveiby.com/articles/KnowledgeOrganizationsAust.html>] says that “If we wish to see the future of corporate Australia, we don’t need a crystal ball or sophisticated forecasts by economists. All we need to do is to visit some of the small fastest growing and most successful knowledge companies. The management styles they are pioneering and the strategies they are pursuing will be the case stories taught in the standard curriculum of the management schools of Australia”. This research is aimed to address this gap. This research investigates the knowledge management practices in SMEs in Australia. This study addresses the following research questions:

- (i) to identify various factors and variables of KM benefits, and
- (ii) to explore and develop a model of KM Benefits

II. The Background

“Knowledge management is.... an approach to adding or creating value by more actively leveraging the know-how, experience, and judgment reside within and, in many cases, outside of an organization.” [26, p. 80].

This definition highlights important elements of knowledge management. The “know-how” aspect of KM emphasizes the “explicit” knowledge, which can be easily captured and codified [5]. On the other hand the “experience” and “judgment” aspects of KM reflects the “tacit” or “implicit” knowledge, which is difficult to capture and formalize [5]. The definition also emphasizes that primary purpose of knowledge management is to add or create “value”.

Based on the literature [24] [25] [21] [3] [15], knowledge basically can be divided into two categories: tacit knowledge and explicit knowledge. Some common applications of tacit knowledge are problem solving, problem finding, and

prediction & anticipation [15]. Tacit knowledge basically consists of two dimensions: cognitive and technical elements [21]. The cognitive dimension of tacit knowledge refers to “mental models”, which assist human beings in interpreting and understanding the world around them; individuals’ perspectives, beliefs, and opinions are some examples of tacit knowledge [21]. The technical element of tacit knowledge includes things such as know-how, crafts, and skills [21]. Tacit knowledge is personal and context-specific; therefore it is more difficult to formalize and communicate [21]. Contrasting to tacit knowledge’s subjective nature, explicit knowledge is more objective and generally can be codified or documented in formal or systematic format [21]. Information in the databases, library, and Internet are some examples of explicit knowledge. Tacit knowledge has much higher value than explicit knowledge since people always know more than they can tell [29, p. 34] [20]. Furthermore, in order to apply explicit knowledge in practices, it must be converted to the tacit knowledge [20]. For example, students have to understand the knowledge, i.e., concepts, definitions, theories, formulas, they learn in the classroom and books before they can apply them to interpret, understand, and solve the problem in reality.

Many of the past studies on innovation diffusion have applied the model(s) by Ajzen & Fishbein [1] (Theory of Reasoned Action (TRA) and Davis [9] (Technology Acceptance Model (TAM)). Basically these researchers have suggested that some external factors influence the perceptions about an innovation, i.e. “External Factors” → “Perceptions”. This simple model is generic in nature and is likely to be applicable, with some adjustments, in various innovation diffusion processes. As mentioned before, the aim of this research is to study, via field study, various factors and variables affecting KM benefits and to investigate to what extent the above generic model is applicable in developing a comprehensive model of KM Benefits.

III. The Operation of Field Study

III.1 Qualitative Research Paradigm

The paradigm of the research is qualitative, in which field study has been used as the research method [23] [37]. The field study adopts a semi-structured interview approach to better understand the participants’ views on knowledge management. The literature review provides the framework for developing and refining the interview questions. It is very common to get qualitative data through interviews. Evidence exists that the interviewing has been used as an effective tool to collect data for thousands of years [33]. Like any other research method, field study involves choosing a sample of companies using either random or non-random method [37]. The details of the field study research process are presented in the subsequent sections below.

III.2 Sample

A convenience sampling procedure was undertaken to select

companies who were willing to be included in the field study. It is noted that convenience sampling is frequently undertaken in business research [37]. Main selection criterion was that the companies must be involved in various stages of knowledge management. Ten companies were selected from the list of companies where our Australian MBA students were employed in Tweed and Gold Coast areas. At least a key person in the company, who has the knowledge of knowledge management, was contacted for interview.

III.3 Data Collection

Semi-structured interview technique was used as the primary vehicle to collect data. The interview plan followed the guidelines of Whiteley et al. [33] and Patton [23]. The final interviews was scheduled as per the convenience of the interviewees, so that there will be minimum disruptions and interruptions in their working schedules. A pre-interview session was conducted first via telephone, which provided each interviewee an idea about the interview process and gave them some food for thought. Each interview lasted for about one hour. With the permission of the interviewees, each interview was recorded using a micro-audio recorder. Each interview was transcribed the following day in order to reflect on the body language and other non-verbal cues fresh from memory.

III.4 Data Analysis via Content Analysis Approach

One of the challenges in qualitative research is data analysis. A number of tools and techniques are available in the literature [18]. These tool(s) must be selected based on the objectives of the research. Since the research in this stage was more exploratory than confirmatory in nature, “content analysis” was chosen as a method in analyzing the interview transcripts [4]. Two-stage content analyses was carried out for data analysis. Stage one dealt with single interview transcripts, while stage two dealt with cross interview transcripts [18].

IV. Results and Discussions

IV.1 Demographic Information

Table-1 presents the demographic information on the companies, which are at different stages of knowledge management, involved in the field study. It is noted that there are two community services clubs, tourism and hospitality service, two real estate services, two health services, two education providers and one IT firm. The size of the company varied from 7 staff to around 200. Table-1 also presents the interviewees’ positions in their organizations.

All companies have adopted some form of knowledge management practices, which are supported by different technologies.

IV.2 Factors and Variables of KM Benefits in SMEs

Altogether six factors and fifty-two variables, which have impact on the knowledge management practices, were identified from different companies via extensive content analyses as described earlier. The six primary factors are:

External inspiring factor, Individual factor, Organizational factor, Management support factor, and KM technology factor and Expected Benefits of KMS.

It is interesting to note that out of 53 variables only five variables are mentioned by all ten companies and one variable is mentioned by nine companies. Some variables are only mentioned by one or two companies. The six variables, chosen by all ten companies, are: “Competitive Pressure”, “Customer Demand and Expectation”, “Top Management Support/ Leadership”, “Organizational Structure”, and “Organizational culture”. Participants of the field study felt that their companies’ initiative on knowledge management have been ignited by the tough competition and intensive competitive pressure in the market place and challenges from customers, who are demanding more value-for-money and expecting better services. Organizations exist within an “open” environment where external influences such as changes in the marketplace influences internal operation [32] [19]. Through fostering collaborative practices and knowledge sharing, knowledge management facilitates the learning about the external environment [14] and the implementation of a successful change management program responding to the external environment [19]. The organizations are implementing knowledge management to learn and respond to their customers better. Through effective knowledge management programs, businesses is also able to provide more enhanced or/ and new products and services. Literature, such as Alavi & Leidner [2]; suggest that knowledge about customer and customers are most important knowledge domains for businesses.

Management and leadership play critical roles in knowledge management [22]. Management provides vision and energy to stimulate and sustain effective knowledge management practices and systems. Leaders have direct impact on the organization’s culture and its knowledge management approaches. Without management’s commitment and emphasis on knowledge management, people won’t take it seriously [10].

Those at the top of an organization should have to find the knowledge needs of the business. Simply investing money in IT only can produce more examples of KM failures and waste of investment. Leaders have to take account issues such as culture, structure, process, training and development. More attention should be given to people since businesses make profits through selling and effectively using their knowledge (tacit knowledge) [28] [16]. One important challenge for leaders is how they can embed knowledge into people’s day-to-day work to help them do their jobs more effectively and efficiently [17]. Besides being role models for learning and knowledge sharing, leaders are responsible for creating a climate of trust where people can share knowledge with confidence [22]. All the

interview participants express the view that support from top management, i.e., understanding the importance of knowledge management, commitment, leadership, is crucial for the success of knowledge management s in organization. For example, the leadership process in General Electric (GE) is all about sharing knowledge and creating knowledge. The top management in GE has focused on the importance of sharing knowledge. The knowledge sharing practice starts at the top [16].

All the participants of the field study share the importance of organizational culture, which influences the effects of other factors (i.e., technology, management practices) of knowledge management practices [30], in contributing to the success of knowledge management. Organizational culture has been increasingly recognized as a major barrier to knowledge management [11] [13]. Organizations have to create an environment where people feel comfortable and are willing to share their knowledge. A knowledge-oriented culture challenges people to share knowledge throughout the organization [7] [13]. In the mean time, the benefits of knowledge management need to be demonstrated, and knowledge-sharing practices should be rewarded with tangible (i.e., financial rewards) and intangible (i.e., recognition) incentives [10].

There is a general agreement among participants that organizational structure facilitates the knowledge sharing and cross-boundary collaboration. Organizations with flexible and organic structure are more likely to achieve the perceived benefits of knowledge management than those organizations that are rigid and bureaucratic [13]. Organizations with a rigid structure must be prepared to re-engineer its organizational structure to facilitate effective knowledge management.

IV. 3 Relationships Among the Factors

Table-2 presents the links among the factors of KM benefits. Column 1 presents the pairs of factors and corresponding direction of links. Information on perceived causal links was sought during the interview process and was extracted from the interview scripts via content analysis. For example, “EI & EB” in row 1 of Table-2 represents that “External Inspiring factor” (EI) impacts “Expected Benefits factor” (PU), and this link has been identified in all the ten companies From this table a causal model of KMS diffusion can be traced for different companies.

IV. 4 A Combined KM Benefits Model

Figure-1 presents the combined model of KM Benefits which has been developed selecting the variables and links mentioned by at least 2 companies. Looking at Figure-1, it is observed that the basic KM Benefits model of “External Factors” → “Expected Benefits”, which was obtained from the literature, applies quite effectively for KM. However, it must be highlighted that the factors and variables are different and very specific to KM practices in SMEs.

IV. 5 Research Implications

Figure-1 presents the comprehensive model of KM benefits. This model is unique in the sense that it has been developed based on the data obtained from ten interviews in ten different companies. Although no formal propositions are developed in this paper, the model can still be taken as a research model for further investigation. For example, a causal modeling approach (structural equation modeling) can be undertaken to test the model. Figure-1 would serve as the basic research model for further exploratory research to develop and test appropriate research hypotheses.

IV. 6 Managerial Implications

Figure-1 also presents a practical model of KM benefits. All the factors/sub-factors and variables have been obtained from the real world. Companies planning to embark on KM can consider the variables of Figure-1 as “criteria” of successful implementation of KM. It must be noted that not all criteria of Figure-1 will be applicable for all companies. A careful analysis is first needed to select the appropriate criteria for the company.

V. Conclusions and Future Study

This paper presents a comprehensive study to determine the factors and variables of KM benefits. In doing so it takes a qualitative field study approach. Six companies took part in the study, which resulted in eight interviews with key person(s) in the companies. The participating companies were in various stages of KM practices. The interviews were transcribed by the researchers and the contents were analyzed thoroughly using a structured process. The analyses resulted in six factors and 52 unique variables. Company specific individual diffusion models were first developed which were then combined to develop a comprehensive KM benefits model.

Five variables identified to be significant for KM success were: “Competitive Pressure”, “Customer Demand and Expectation”, “Top Management Support/ Leadership”, “Organizational Structure”, “Organizational culture”, and “Top Management Support”. These variables were mentioned by all the ten companies. Organizations planning to embark on KM or currently practicing some parts of KM should look into these variables carefully for successful implementation of KM.

This study contributes to the KM literature in the following ways. It used a qualitative research method to develop the factors, variables and comprehensive model. The research was thus exploratory in nature. It must be mentioned that most of the existing research in KM are quantitative in nature, i.e., hypothesis testing confirmatory type. The comprehensive model can be used to undertake further research and thus add value to the literature on knowledge management. The paper elaborated on how the combined model can be used to undertake further research and how it can also be used for practical applications in companies which are embarking on KM.

The researchers’ future plan is to study the combined

model further using a structural equation modeling approach. This part of the research will use a quantitative approach, which will test a number of hypotheses and the model itself.

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Table-1 Demographic Information

	Company 1	Company 2	Company 3	Company 4	Company 5	Company 6	Company 7	Company 8	Company 9	Company 10
Nature of Business	IT (Software Development, sales and support)	Tourism and Hospitality Services	Aged Care services and community health services	Education	Community Services Club (Entertainment and Leisure)	Education	Real Estate Services	Community Services Club (Entertainment and Leisure)	Health Services	Real Estate Services
Size	7	37	88	119	190	14	14	110	14	60
Interview Participants' Position	Owner	CEO	HR Manager	Principal	PR Manager	General Manager	Owner Manager	CEO	Office Administration Manager	Managing Director
KM Status	Advanced KM Practices	Just Thinking	Limited	Just Starting	Never Thought About it	Limited KM Practices	Never Thought About it	Limited KM practices due to complexity of workplace	Some KM practices	Limited KM Practices

Table-2 Casual Links Among the Factors

	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5	Comp 6	Comp 7	Comp 8	Comp 9	Comp 10	Frequency
External Inspiring Factors											
EI & EB	√	√	√	√	√	√	√	√	√	√	10
ID & EB	√	√	√	√	√	√	√	√	√	√	10
MS & EB	√	√	√	√	√	√	√	√	√	√	10
KMT & EB	√	√	√	√	√	√	√	√	√	√	10
ORG & EB	√	√	√	√	√	√	√	√	√	√	10

Note: EI- External Inspiring Factor

ID-Individual Differences Factor

MS-Management Support Factor

KMT: Knowledge Management Technology

ORG-Organizational Factor

EB: Expected Benefits

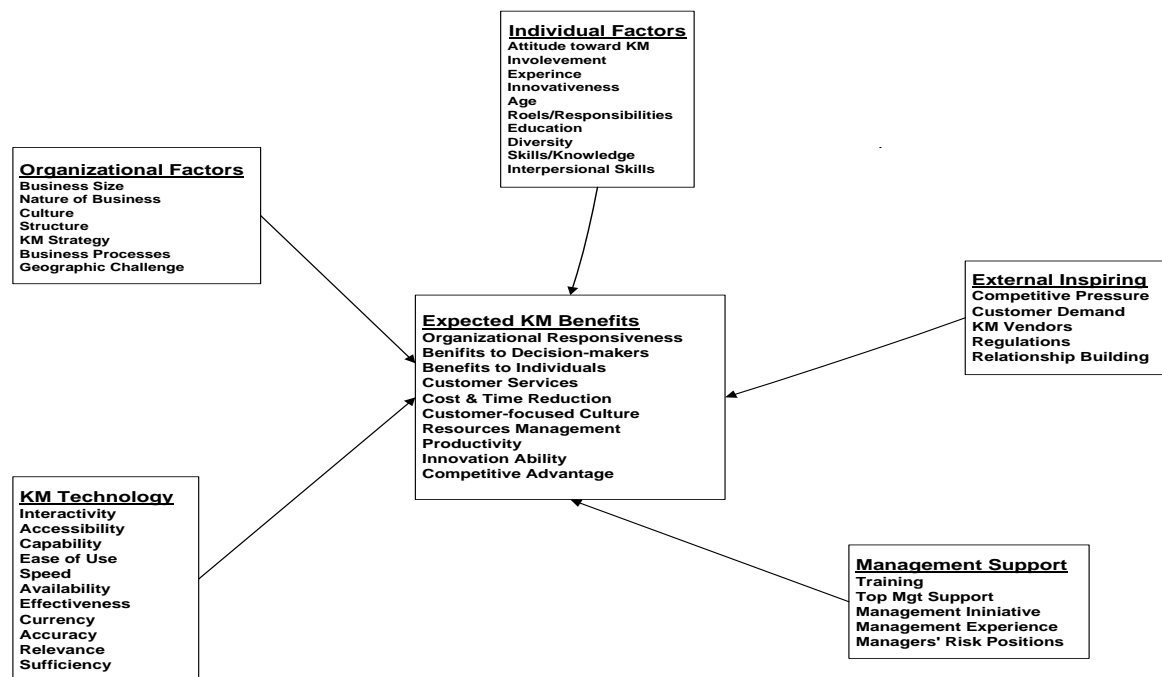


Figure-1 Combined KM Benefits Model

Does Size Matter in Knowledge Management: A Comparison between Large Organizations and SMEs

Jun Xu¹, Mohamemd Quaddus², Shankar Sankaran¹, Ben Faranda¹

¹Graduate College of Management
Southern Cross University, Australia
Tweed Gold Coast campus, Brett Street, Tweed Heads
PO Box 42, Tweed Heads, NSW 2485, Australia
²Graduate School of Business
Curtin University of Technology, Australia
GPO Box U 1987, Perth, WA 6845, Australia
E-mail: jxu@scu.edu.au

Abstract: This research intends to identify the differences and similarities of knowledge management in Large organizations and Small and Medium size enterprises (SMEs). Primary data were collected by interviewing five large businesses and ten SMEs. Besides the academic contribution to the field of knowledge management, this research will be able to provide applicable and practicable suggestions on the knowledge management practices to businesses in Australia.

Keywords: Knowledge Management, SMEs, Australia, Qualitative Methods, Content Analysis

I. Introduction

Knowledge management is not new. Human beings have been practicing knowledge management as early as 4,000 years ago when the earliest civilization evolved [44]. Knowledge management refers to a systematic and organizational specific framework to capture, acquire, organize, and communicate both tacit and explicit knowledge of employees so that other employees may utilize them to be more effective and productive in their work and maximize organization's knowledge [1] [11]. Knowledge management includes four knowledge processes: knowledge creation, knowledge storage, knowledge distribution, and knowledge application [1] [43].

Literature has defined knowledge management (KM) in a number of ways [5] [7] [8] [14] [22] [34]. For example, Carayannis [6, p. 219] suggests that knowledge management "can be viewed as a sociotechnical system of tacit and explicit business policies and practices. These are enabled by the strategic integration of information technology tools, business processes, and intellectual, human, and social capital". Wiig [43, p. 458] defines knowledge management as "the field of deliberately and systematically analysing, synthesizing, assessing, and implementing knowledge related changes to attain a set of objectives". Sveiby [38, <http://www.sveiby.com/articles/IntellectualCapital.html>] describes knowledge management as "the art of creating

value and form an organization's intangible assets". Sarvary [33, p. 95] defines knowledge management as "a business process". It is the process through which firms create and use their institutional or collective knowledge. Saffady (1998, p. 3) views knowledge management as "the systematic, effective management and utilization of an organization's knowledge resources". Malhotra [21], <http://www.brint.com/interview/maeil.htm> defines knowledge management as "Knowledge Management caters to the critical issues of organizational adaption, survival and competence in face of increasingly discontinuous environmental change. Essentially, it embodies organizational processes that seek synergistic combination of data and information processing capacity of information technologies, and the creative and innovative capacity of human beings". Amercian Productivity & Quality Center [3, p. 7] views knowledge management as "the strategies and processes of identifying, capturing, and leveraging knowledge to help the firm compete".

In this study, the definition by Ruggles [31] is adopted, which is as follows:

"KM is.... an approach to adding or creating value by more actively leveraging the know-how, experience, and judgment reside within and, in many cases, outside of an organization." [31, p. 80].

This definition highlights important elements of knowledge management. The "know-how" aspect of KM emphasizes the "explicit" knowledge, which can be easily captured and codified [5]. On the other hand the "experience" and "judgment" aspects of KM reflects the "tacit" or "implicit" knowledge, which is difficult to capture and formalize [5]. The definition also emphasizes that primary purpose of knowledge management is to add or create "value".

Based on the literature [2] [18] [26] [29] [30] [35], knowledge basically can be divided into two categories: tacit knowledge and explicit knowledge. Some common applications of tacit knowledge are problem solving, problem finding, and prediction & anticipation [18]. Tacit knowledge basically consists of two dimensions: cognitive and technical elements [26]. The cognitive dimension of tacit knowledge refers to "mental models", which assist human beings in interpreting and understanding the world around them; individuals' perspectives, beliefs, and opinions are

some examples of tacit knowledge [26]. The technical element of tacit knowledge includes things such as know-how, crafts, and skills [26]. Tacit knowledge is personal and context-specific; therefore it is more difficult to formalize and communicate [26]. Contrasting to tacit knowledge's subjective nature, explicit knowledge is more objective and generally can be codified or documented in formal or systematic format [26]. Information in the databases, library, and Internet are some examples of explicit knowledge. Tacit knowledge has much higher value than explicit knowledge since people always know more than they can tell [37, p. 34] [25]. Furthermore, in order to apply explicit knowledge in practices, it must be converted to the tacit knowledge [25]. For example, students have to understand the knowledge, i.e., concepts, definitions, theories, formulas, they learn in the classroom and books before they can apply them to interpret, understand, and solve the problem in reality.

A lot of research has been done on the knowledge management in large organizations. However the literature on the knowledge management in comparison between large businesses (more than 200 staff) and SMEs (less than 200 staff) is very limited. This research is aimed to address this gap. This research investigates the knowledge management practices in SMEs in Australia. This study addresses the following research questions:

- (i) to identify significant factors of knowledge management in large and small & medium businesses
- (ii) to identify the differences and similarities of these significant factors

II. The Operation of Field Study

II. 1 Qualitative Research Paradigm

The paradigm of the research is qualitative, in which field study has been used as the research method [28] [45]. The field study adopts a semi-structured interview approach to better understand the participants' views on knowledge management. The literature review provides the framework for developing and refining the interview questions. It is very common to get qualitative data through interviews. Evidence exists that the interviewing has been used as an effective tool to collect data for thousands of years [42]. Like any other research method, field study involves choosing a sample of companies using either random or non-random method [45]. The details of the field study research process are presented in the subsequent sections below.

II. 2 Sample

A convenience sampling procedure was undertaken to select companies who were willing to be included in the field study. It is noted that convenience sampling is frequently undertaken in business research [45]. Main selection criterion was that the companies must be involved in various stages of knowledge management. Five large businesses and ten small and medium size companies took part in the study. At least a key person in the company, who has the

knowledge of knowledge management, was contacted for interview.

II. 3 Data Collection

Semi-structured interview technique was used as the primary vehicle to collect data. The interview plan followed the guidelines of Whiteley et al. [42] and Patton [28]. The final interviews was scheduled as per the convenience of the interviewees, so that there will be minimum disruptions and interruptions in their working schedules. A pre-interview session was conducted first via telephone, which provided each interviewee an idea about the interview process and gave them some food for thought. Each interview lasted for about one hour. With the permission of the interviewees, each interview was recorded using a micro-audio recorder. Each interview was transcribed the following day in order to reflect on the body language and other non-verbal cues fresh from memory.

II. 4 Data Analysis via Content Analysis Approach

One of the challenges in qualitative research is data analysis. A number of tools and techniques are available in the literature [23]. These tool(s) must be selected based on the objectives of the research. Since the research in this stage was more exploratory than confirmatory in nature, "content analysis" was chosen as a method in analyzing the interview transcripts [4]. Two-stage content analyses was carried out for data analysis. Stage one dealt with single interview transcripts, while stage two dealt with cross interview transcripts [23].

III. Results and Discussions

III. 1 Demographic Information

Table-1& 2 presents the demographic information on the companies involved in the field study. It is noted that among 10 SME participants (see Table-2) there are two community services clubs, tourism and hospitality service, two real estate services, two health services, two education providers and one IT firm. The size of the company varied from 7 staff to around 200. In the meant time, among five large business participants there are two government organizations and four private companies (one mineral resource, one consulting, one engineering and one software development). Size of the company varies from 200 staff to over 4000 staff. One private company and one public organization have knowledge manager or chief knowledge officer on board. All companies are involved in various stages of knowledge management Table-1& 2 also presents the interviewees' positions in their organizations.

III. 2 Significant Factors of Knowledge Management

Table-3 presents significant factors of knowledge management for both large and S&M businesses. The six significant factors of KM for SMEs, chosen by all ten companies, are: "*Competitive Pressure*", "*Customer Demand and Expectation*", "*Top Management*

Support/ Leadership”, “*Organizational Structure*”, and “*Organizational culture*”. The four significant factors for large businesses, chosen by all five companies, are: “*Organizational Culture*”, “*Organizational Structure*”, “*Top management support*”, and “*Benefits to individuals*”.

Table-3 Significant Factors of Knowledge Management

	SMEs	Large Businesses
External Factors	Competitive Pressure Customer Demand and Expectation	
Internal Factors	Top Management Support/ Leadership Organizational Structure Organizational culture	Organizational Culture Organizational Structure Top management support Benefits to individuals

IV. Interpretation and Discussion

IV.1 External Factors

SMEs Participants of the field study felt that their companies’ initiative on knowledge management have been ignited by the tough competition and intensive competitive pressure in the market place and challenges from customers, who are demanding more value-for-money and expecting better services. Organizations exist within an “open” environment where external influences such as changes in the marketplace influences internal operation [24] [41]. Through fostering collaborative practices and knowledge sharing, knowledge management facilitates the learning about the external environment [17] and the implementation of a successful change management program responding to the external environment [24]. The organizations are implementing knowledge management to learn and respond to their customers better. Through effective knowledge management programs, businesses is also able to provide more enhanced or/ and new products and services. Literature, such as Alavi & Leidner 1999 [1]; suggest that knowledge about customer and customers are most important knowledge domains for businesses. In the mean time, 3 out of 5 participants from large organizations also indicated the importance of Competition and Customer Demand.

IV.2 Internal Factors

Management Support

Management and leadership play critical roles in knowledge management [27], which is shared by both large and S&M businesses. Management provides vision and energy to stimulate and sustain effective knowledge management

practices and systems. Leaders have direct impact on the organization’s culture and its knowledge management approaches. Without management’s commitment and emphasis on knowledge management, people won’t take it seriously [12]. Those at the top of an organization should have to find the knowledge needs of the business. Simply investing money in IT only can produce more examples of KM failures and waste of investment. Leaders have to take account issues such as culture, structure, process, training and development. More attention should be given to people since businesses make profits through selling and effectively using their knowledge (tacit knowledge) [19] [36]. One important challenge for leaders is how they can embed knowledge into people’s day-to-day work to help them do their jobs more effectively and efficiently [20]. Besides being role models for learning and knowledge sharing, leaders are responsible for creating a climate of trust where people can share knowledge with confidence [27]. All the interview participants express the view that support from top management, i.e., understanding the importance of knowledge management, commitment, leadership, is crucial for the success of knowledge management s in organization. For example, the leadership process in General Electric (GE) is all about sharing knowledge and creating knowledge. The top management in GE has focused on the importance of sharing knowledge. The knowledge sharing practice starts at the top [19].

Organizational Culture

All the participants (both large and S&M businesses) of the field study share the importance of organizational culture, which influences the effects of other factors (i.e., technology, management practices) of knowledge management practices [39], in contributing to the success of knowledge management. Organizational culture has been increasingly recognized as a major barrier to knowledge management [13] [15]. Organizations have to create an environment where people feel comfortable and are willing to share their knowledge. A knowledge-oriented culture challenges people to share knowledge throughout the organization [10] [24]. In the mean time, the benefits of knowledge management need to be demonstrated, and knowledge-sharing practices should be rewarded with tangible (i.e., financial rewards) and intangible (i.e., recognition) incentives [12].

Organizational Structure

There is a general agreement among SMEs and large business participants that organizational structure facilitates the knowledge sharing and cross-boundary collaboration. Organizations with flexible and organic structure are more likely to achieve the perceived benefits of knowledge management than those organizations that are rigid and bureaucratic [15]. Organizations with a rigid structure must be prepared to re-engineer its organizational structure to facilitate effective knowledge management.

Benefits to Individuals

The factor, *benefits to individuals*, is perhaps most important for the success of KM. "What's in it for me" is always a popular comment by individuals when any new venture is initiated in an organization. Individuals will not buy into knowledge management if they can't identify clear benefits in using it. Although this factor was highlighted by all large business participants, it was not considered important by all SME participants.

IV. 3 The Role of Business Size in Knowledge Management

Past research has reported the impact of size in the adoption of technology. For example, Thong [40] reports that organizational size is positively related to the organization's adoption decision of information systems. Dasgupta et al. [9] report that larger organizations are more likely to adopt information technology. Sarvary [33] suggests that large firms with large customer base tend to perceive a KMS more useful and have a better chance to apply KMS to build sustain competitive advantage.

The results of this study basically indicates basically there is no major difference in significant factors of KM between large and S&M businesses across different industry. So does the concept of KM. In today's highly competitive market environment, all the companies have to practice knowledge management and it is quite impossible to survive the severe competition without managing knowledge in the knowledge economy. Perhaps larger companies are practising knowledge management more consciously and systematically than smaller businesses. And the former could also use more or more advanced IT technologies to manage their knowledge.

V. Conclusions and Future Study

This paper presents a comparison study of knowledge management between large and small & medium businesses. In doing so it takes a qualitative field study approach. Fifteen companies took part in the study, which resulted in eight interviews with key person(s) in the companies. The participating companies were in various stages of KM practices. The interviews were transcribed by the researchers and the contents were analyzed thoroughly using a structured process.

Three variables identified to be significant for KM success in both SMEs and large businesses were: "*Organizational Structure*", "*Organizational culture*", and "*Top Management Support*". These variables were mentioned by all the companies. Organizations planning to embark on KM or currently practicing some parts of KM should look into these variables carefully for successful implementation of KM.

This study contributes to the KM literature in the following ways. It used a qualitative research method to develop the factors, variables and comprehensive model. The research was thus exploratory in nature. It must be mentioned that most of the existing research in KM are

quantitative in nature, i.e., hypothesis testing confirmatory type. The comprehensive model can be used to undertake further research and thus add value to the literature on knowledge management. The paper elaborated on how the combined model can be used to undertake further research and how it can also be used for practical applications in companies which are embarking on KM.

The researchers' future plan is to develop a model of knowledge management success and test the moderating impact of size and other factors such as industry sector, business models, etc. This part of the research will use a quantitative approach, which will test a number of hypotheses and the model itself.

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Table-1 Demographic Information of SMEs

	Com 1	Com 2	Com 3	Com 4	Com 5	Com 6	Com 7	Com 8	Com 9	Com 10
Nature of Business	IT (Software Development, sales and support)	Tourism and Hospitality Services	Aged Care services and community health services	Education	Community Services Club (Entertainment and Leisure)	Educ-ation	Real Estate Services	Comm-unity Services Club (Enter-tainment and Leisure)	Health Ser-vices	Real Estate Ser-vices
Size	7	37	88	119	190	14	14	110	14	60
Interview Participants' Position	Owner	CEO	HR Manager	Principal	PR Manager	General Manager	Ow-ner	CEO	Office Admin Man-ager	Man-aging Direc-tor

Table-2 Demographic Information of Large Organizations

	Company 1	Company 2	Company 3	Company 4	Company 5
Nature of Business	Public Service (Resources preservation)	Mineral Resources	Consulting (International)	Public Service (Justice)	Engineering & Construction (Multinational)
Size	>2,00	593	4,500	>2,00	4000
Interview Participant's Position	Director of Strategic Development & Corporate Affairs	Managing Director	National Board Member & Partner	Change & Knowledge Manager	1. Director & Chief Financial Officer 2. Director of Business Development & Director of Corporate Affairs 3. Manager-Business Proposal

Information Technology Management at a Religious Organization

Albert Huang
Eberhardt School of Business, University of the Pacific
Stockton, California, USA 95211
EMAIL: Ahuang@Pacific.Edu

Abstract: Religious organizations face many of the same problems that business organizations face. The study describes information technology management issues facing a mid size religious organization, and the process it went through to organize its knowledge management efforts.

Keywords: Knowledge management, religious organizations, information systems.

I. Introduction

Religious organizations face many of the same problems that business organizations face. Administrators of religious organizations perform many functions business managers perform. Therefore, they face similar information technology management challenges faced by regular for profit businesses. This case study reports challenges facing a midsize religious diocese and its many parishes located in the United States and recommendations made by a team of external consultants.

II. Background

The diocese is located in a western state in the US. It comprises several counties and covers over 10,000 square miles. The total population in the diocese exceeds one million people. The number of members of the diocese is more than 200,000, almost twenty percent of the total population. There more than eighty priests assigned to various parishes in the diocese. In addition to a wide geographical coverage, the diocese is also ethnically diverse.

To facilitate management and administration, the diocese has adopted computer technology to help manage information. In the past decade, the diocese manages and supports an internal computer network with typical productivity tools to assist with the daily operations of the organization. The diocese has a website that provides a large amount of information to its members and the public. While the diocese is fulfilling its fundamental mission for the church, it has been challenged with growth and limited resources to

manage the information interdependency among its parishes, parishioners and its governing organizations.

III. Current Technology Status

Proper technology to facilitate better communication between the diocese and parishes is a high priority. Currently, a variety of communication methods are used. Most parishes rely on low-tech channels, such as postal service, telephones, and fax machines. Only a small portion use e-mail frequently.

Slightly more than 50 percent of parishes have their own Web pages. The majority of parishes own more than five computers. Two-third of the parishes has local area networks. A variety of software applications are used for various purposes.

IV. Initiative

The bishop of the diocese decided to employ an external consulting group to look into the technology infrastructure of the diocese and make recommendations to improve its information technology and information management. The consultants were brought in to meet with the top administrators and survey the parishes. The existing systems, users, and applications were analyzed.

V. Results

After detailed information gathering and analysis, the consultants made a series of recommendations:

1. Automation in parishes
2. Create a centralized file server at the diocese
3. User training
4. Establish a virtual private network between parishes and the diocese
5. Replace some existing applications with new ones that facilitate information exchange with other applications

Key Elements in an Effective Knowledge Management System: A Case Study Approach

Indrit Troshani, Sally Rao
School of Commerce
The University of Adelaide
233 North Terrace, Adelaide, SA 5005, Australia
Ph: {+61 8 8303 5526, +61 8 8303 4237}
Fax: {+61 8 8303 4368, +61 8 8303 4368}
Email: {indrit.troshani, sally.rao}@adelaide.edu.au

Extended Abstract

Increasingly knowledge is acknowledged to be the most important resource in organisations. There is evidence in the literature that suggests that as organisations use knowledge effectively in their day-to-day operations they become more successful and therefore more valuable than their competitors who do not.

Knowledge management is important for several reasons. First, knowledge management literature argues that knowledge has become a significant competitive tool (Rowley, 1999). Many acknowledge that in today's knowledge-based economy, knowledge, rather than capital and labour, is the "only meaningful economic resource" (Drucker, 1993, Webber, 1993) or "their most valuable and strategic resource" (Zack, 1999). Second, managing knowledge is significantly different from managing other organisational assets. Stewart et al. (2000) argue that knowledge assets are different to physical assets with respect to three characteristics, namely, life, scope, and maintainability (Stewart et al., 2000). It follows that traditional physical asset management know-how may not be readily transferred to knowledge management. In addition, Sunassee & Sewry (2002) argue that the collective knowledge of an organisation's employees is a critical resource to an organisation and managers need to know how to manage it. Third, knowledge management is important because today's business environment is highly competitive. With an ever-changing customer needs and technology, organisations need to have the appropriate information and knowledge at the right time if they are going to make proper decision in a timely fashion (Sunassee and Sewry, 2002). However a review of knowledge management literature suggests that there are a number of issues where research is still at its infancy and which require further investigation. Some of these issues are highlighted in this section. Thus the aim of this paper is to identify the gaps in the literature and provide an agenda for further research.

To begin, knowledge can be defined as 'a symbolic representation built into basic primitives that can be manipulated by rules' and is based on the meaning of *data* and *information* (Spiegler, 2000). Information that is acted

upon and results in decisions and actions which add value to the organisation is knowledge (Kanter, 1999, Spiegler, 2000). The difference between information and knowledge is the same as the difference between *knowing-that* and *knowing-how* (Ryle, 1949). Taking one step further, knowledge management is a systematic process with the purpose of acquiring, organising, both tacit and implicit knowledge (Alavi and Leidner, 1999) to enable other employees to use the collected information in order to be more effective and productive (Alavi and Leidner, 1999). Thus, knowledge management is essentially creation and sharing of organisational knowledge, which is very important because it may determine an organisation's ability to establish and sustain competitive advantage (Grant, 1996).

In order for knowledge management to be efficient automated systems may be required. A knowledge management systems facilitates collecting, codifying, integrating and disseminating knowledge in an organisation (Alavi and Leidner, 1999). The main feature of knowledge management systems is that they can improve the capability of organisations to be more flexible and responsive to changing market conditions. In their survey of 109 respondents in several organisations in 12 countries around the world, Alavi & Leidner (1999) found that an "integrated and integrative technology architecture is a key driver for KMS [knowledge management system]" (p. 22). Specifically, this technology architecture consists of database and database management, communication and messaging, and browsing and retrieval (Alavi and Leidner, 1999). According to Alavi & Leidner (1999) the knowledge management systems are perceived to have a deep impact on organisational processes in terms of enhanced communication, and process efficiency leading to overall enhanced financial and marketing outcomes.

Knowledge management literature highlights that there are several important factors that need to be considered when knowledge management strategies are designed to ensure that knowledge flows effectively and efficiently within the organisation in order to carry out its vision and goals. First, knowledge management strategies should be consistent with the overall organisation business strategy if it is going to provide an organisation with a competitive edge (King, 2001.). Second, people and their contribution are seen as an important component in the knowledge management initiatives of an organisation (Bhatt, 2000). Specifically, top-

management support and employee commitment are key factors. Third, technology also plays a role and is also seen to play an important role because it provides the means and the infrastructure necessary to accomplish knowledge management outcomes.

There appears to be agreement in literature suggesting that knowledge management initiatives should be people-rather than technology-centric (Vandenbosch and Ginzberg, 1997). This is because while technology can at the very best help convert data into information, only people can ascribe 'meaning' to that information turning it into knowledge. On the other hand, technology enables more effective knowledge management (Alavi and Leidner, 1999). In addition, different people in an organisation are likely to deduce different meanings from information. Therefore, over-emphasizing either people or technology or both may not be sufficient for knowledge management strategies to be successful. The interaction between people, technologies and the techniques people apply in exploiting these technologies may be one of the critical success factors of knowledge management strategies (Bhatt, 2001). The success of this interaction depends on organisational culture (Srinivasan, 2004) and will integrate different realities into a unique body of knowledge in the organisation allowing the organisation to act with a "collective mind" (Weick and Roberts, 1993). However a review of knowledge management literature suggests that there are a number of issues where research is still at its infancy and which require further investigation. Some of these issues are highlighted in this section. First, how can knowledge management effectiveness and benefits be measured. This is important because without effective measures it is difficult to conduct cost-benefit analyses and consequently determine the effectiveness of knowledge management investments. Yet, measuring knowledge management benefits can be a difficult task because often knowledge management outcomes are social and only impact organisational profits indirectly (de Gooijer, 2000). Second, given the importance of knowledge management and the need to cultivate a related culture,

organisations need to 'move beyond knowledge pull into knowledge push' (Ezingeard et al., 2000). This suggests that individual knowledge needs and knowledge profiling are important if individuals are to accept the new knowledge management culture (Ezingeard et al., 2000). Third, given that many organisations (e.g. Ernst & Young, etc.) are global, the pressing issue is how such organisations can globalise their knowledge management initiatives in order to gain competitive advantage. Further research is needed in these areas (Eriksson et al., 2000).

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A Knowledge-Based Innovation for High Technology Industries and Applying to Cross Strait Marketplaces

Chen Te Fu

Lecturer, Cheng Shiu University, Taiwan

Ph.D. Candidate, School of management

University of western Sydney, Australia

Email: phd2004_05@yahoo.com

Abstract: The study discusses after China and Taiwan has finally cleared all the hurdles to gaining World Trade Organization (WTO) membership, joining in November 2001. However, foreign investors in China are increasingly embroiled in disputes with Chinese companies due to innovation barriers. Besides, after China and Taiwan joint WTO, high tech industrial competition faces globalization and digitalization two big problems. Therefore, this paper examines the notion that China's and Taiwan's entry into the WTO and their innovation reforms in line with globalization and digitalization have a significant impact on the entire system of knowledge-based innovation management.

Firstly, the study reviews innovation through a knowledge-based theory lens in the innovation supporting processes to construct a research framework. Internally, the supporting innovation processes include knowledge and technology innovation, Managing & organizing innovation. Externally, the supporting innovation processes include inter-organization networks, innovation networks and e-knowledge networks and cooperation innovation.

Secondly, the study through case studies critically investigates the supporting processes of innovation management in China and Taiwan in the context of their WTO entry, and puts forward exploratory ideas that may assist in creating a blueprint for deepening China's and Taiwan's innovation reforms. Under knowledge based and digital economy, how to overcome barriers of knowledge based innovation over the cross-strait and global markets are the most key factors for firm's survival. To answer these questions, in this paper, a more complete integrated innovation model and knowledge based innovation supply chain (KISC) for exploring and determining innovative supporting process in high tech industries and applying to cross strait (China and Taiwan) marketplace is presented. The results of the study will benefit not only the construction of knowledge based innovation framework, but also the business model transformation of competitive advantage.

Keywords: Knowledge management, innovation, high technology, ISC, WTO.

I. Introduction

I.1 Background and Motivation

Stepping into knowledge economy in 21 century, after almost fifteen years of lobbying and negotiation, China and Taiwan have finally cleared all the hurdles to gaining World Trade Organization (WTO) membership, joining in November 2001.

In response to the intensification of global competition, many firms throughout the world have developed international operation strategies to establish a worldwide production, distribution, and marketing network. Investments in manufacturing in China are frequently made due to the strategic benefits that they can bring. Fast economic growth, low labor costs, and a potentially huge domestic market have all led to significant increases in foreign investment in the People's Republic of China. Taiwan is the most investment country in China and its economy and high tech industries also is the most significant impact on cross strait (China and Taiwan) markets.

China has one of the world's largest untapped reservoirs of inexpensive labor, the importance of China's labor force is not just in its sheer size, but in its quality, which is improving steadily as a result of the training and educational reforms being introduced throughout the country. Over 14 million Chinese are employed in enterprises created by foreign investment, and more than one hundred Fortune 500 companies have operations in China. Dynamic technological advances and rapid economic globalization have changed China's international business climate to a significant extent. In future, China may influence the world as a source of raw materials, as an international manufacturing center, and as a major importer and exporter of consumer products, capital goods, and high technology. A new economic order in China – the globalization of business – has both shaped and been shaped by the advancements in knowledge and innovation management that have improved the efficiency and effectiveness between markets, manufacturing processing, and resources.

China's unprecedented economic growth and globalization have strained its knowledge-economy and innovation infrastructure to the limit. Knowledge-based innovation – the movement of technology, people, processes and information – has a significant impact on a society's standard of living. The innovative process affects every sphere of human activity and business strategy. Innovation is a significant component of the competitive advantage most enterprises incur, as life cycle of products is shorter and shorter and competing in marketplace is fiercely more and more, particularly in high tech industries. Efficient innovat-

ion management involves a successful integration of knowledge and technology that facilitates the innovative processes of products to the consumers at the right time and right place in accordance with consumer needs. As an increasing number of foreign manufacturers are establishing joint ventures in China, the demand for higher quality innovative management is growing tremendously. The reason for this growth in demand is simple: if foreign companies encounter too many innovative problems and barriers in China, to the extent that the total costs of utilizing China as a manufacturing base become too high when compared with other nations, then China will be excluded from a foreign firm's global manufacturing network.

However, foreign investors in China are increasingly embroiled in disputes with Chinese companies due to knowledge and innovation barriers. With continual innovation reforms, there are tremendous opportunities to fundamentally improve the knowledge-based innovation theory and practice. But the existing literature reveals very little systematic research in this area from the knowledge-based perspective.

In other side, during past twenty years, the most successful two high tech industries are IT industries and semiconductor industries. These two industries represent Taiwan's successfully turn around from labor intensity to capital intensity and technology intensity of high tech industries.

Nevertheless, Taiwan also faces three big problems:

1. The most industries move into China even though high tech industries.
2. Economic decline is increasingly
3. The jobless problems are serious increasingly. Recently, large volumes of industries were shifted out to China for survival even though high tech industries. The large markets and cheap labor cost is attracting for Taiwan's industries. But China this "resource black hole" will inhale how much Taiwan's industries and related resources is the big problem and dilemma for government and industries in Taiwan.

Facing the shifting of Taiwan traditional and high tech industries, the unique development of Taiwan's industries is to develop new domain just can create next wave's industrial survival space. Just like twenty years ago, Taiwan has used PC to replace calculating and game machine.

Taiwan's high tech industries have their advantage, if they could implement continue innovation, sustainable acquiring new knowledge, create new knowledge and applying new knowledge, the they must can sustainable develop successfully.

In these two years, many multinational corporations create innovation and R&D center in Taiwan. For example, there are Dell, HP, Sony, IBM and Microsoft and so on. Under fiercely competitive high tech industries environment, they have willing to invest in Taiwan are because Taiwan has many advantage of high tech industries as below.

1. Complete IT industrial supply chain. Industrial high "group gather degree" and own quickly logistics abilities, thus to form advantage of economic scale. It can decrease competitive cost.

2. Taiwan owns high quality R&D and production manpower and the advantage of lower R&D cost.

3. During past 30 to 40 years, many Taiwanese in USA are CEO or Boss of USA high tech industries. After their life and business are developed until mature term, many of them emerge minds to go back Taiwan.

4. The global main consumer markets is increasingly shift from northern America and Europe to Asia, Taiwan owns the advantage of nearing markets and it can provide integrated system services from designing, developing to manufacturing.

5. Taiwan government promotes supporting of industrial policy. It supply large R&D allowances and preferential of encouraging industries...and so on.

6. In 1990, USA has shifted out their production; this gave strong chance for Taiwan's high tech industries. Currently, USA starting to shift out R&D, Parent companies of USA focus on marketing and brand. This gives chance for turning around and upgrading for Taiwan's high tech industries again.

Base on above advantages, Taiwan's high tech industries need to start integrating design and R&D of USA and Japan and to create Taiwan as a "knowledge based innovation" center for supporting corporate innovation among cross-strait market. Furthermore, to extend Taiwan's high tech industries from "manufacturing style" to "innovation R&D style" and to develop value added of product even though to create own brand. Then Taiwan's high tech industries just can walk toward another milestone under large pressure of industrial shifting out to Mainland China.

1.2 Research Problems

Despite the attractive low cost environment, foreign companies and investors may still find it unprofitable to operate in China should there be serious problems in getting innovative sources to the factories and products to the customers in good condition and on time. Evidence from the literature reveals that foreign manufacturing operations in China do not find the innovative resources provided by Chinese enterprises satisfactory. Therefore, the most important issue will be which resources of innovation supporting processes are necessary to manage innovation in the knowledge intensive industry like high tech industries after China's and Taiwan's entry into the WTO?

According to abovementioned, the study assumed there are five research problems as follows:

1. How to through the advancements in knowledge and innovation management to improve the efficiency and effectiveness in cross strait markets, manufacturing processing, and resources?
2. How to acquire the supporting innovative resources from inside and outside of high tech industries?

3. How to through innovation supply chain to help Taiwan's high tech industries to maintain sustainable competitive advantage and reengineer from past manufacturing center to innovative research & development center.
4. Which resources of innovation supporting processes are necessary to manage innovation in the knowledge intensive industry like high tech industries after China's and Taiwan's entry into the WTO?

How to develop a complete integrated innovation model to reach above goals.

I. 3 Research Objective

In future, China may influence the world as a source of raw materials, as an international manufacturing center, and as a major importer and exporter of consumer products, capital goods, and high technology. A new economic order in China – the globalization of business – has both shaped and been shaped by the advancements in knowledge and innovation management that have improved the efficiency and effectiveness between markets, manufacturing processing, and resources. According to the best market place nearing position and large volumes of high tech talent, Taiwan should be changed from past manufacturing center to innovative research & development center. This strategy could help Taiwan and China to acquire win-win situation.

As one of the most important points of knowledge, innovation organizations should embody the ability to create, disseminate and transfer knowledge. Organizational innovation should be a major prerequisite for other innovations. This has special significance for innovation organizations. However, there is an urgency to study the best structure, management methods and functions of organizations in order to establish a healthy research atmosphere and create a new culture of innovation organizations.

The main objective of the study is to provide a complete and practical integrated model for high tech industries and applying to cross strait (Chinese and Taiwan) markets. The existing literature reveals very little systematic research in this area from the knowledge-based perspective. With continual innovation reforms, there are tremendous opportunities to fundamentally improve the knowledge-based innovation theory and practice.

Therefore, firstly, this paper will examine the notion that China's and Taiwan's entry into the WTO and their innovation reforms in line with globalization and digitalization have a significant impact on the entire system of knowledge-based innovation management. Secondly, this paper will critically investigate the supporting processes of innovation management in China and Taiwan in the context of their WTO entry, and puts forward exploratory ideas that may assist in creating a blueprint for deepening China's and Taiwan's innovation reforms and for supporting high technology industrial continues innovation.

Finally, for reaching above goals, the study will develop

an integrated innovation model to support internal and external innovative processes for high tech industries between China and Taiwan. The objectives of the study is to provide a more complete and practical integrated innovation model to link theory and practice for high tech industries and applying to cross strait (Chinese and Taiwan) markets.

II. Literature Review

II. 1 Sources of Innovation

The foremost management consultant of our time, Peter F. Drucker [52], promoted a provocative concept on how to make a profit: "Because its purpose is to create a customer, the business enterprise has two--and only two--basic functions: marketing and innovation. Marketing and innovation produce results: all the rest are 'costs'." He further taught that bright ideas are the riskiest and least successful source of innovative opportunities. Instead, he advised the systematic, managed, purposeful and organized search for changes and the systematic, managed, purposeful and organized analysis of the opportunities such changes might offer for innovation.

He said that to 'practice' innovation, we must be students of change, and suggested monitoring seven sources for innovation opportunities. Four of these lie within the enterprise and are primarily visible to people within that industry or service sector. Three involve changes outside the enterprise or industry. Here is a list of the seven sources, taken from his book, *Innovation and Entrepreneurship: Practice and Principles*.

1. The unexpected. The unexpected success, failure or outside event.
2. The incongruity-- between reality as it actually is and reality as it is assumed to be or as it "ought to be."
3. Innovation based on process need.
4. Changes in industry structure or market structure that catches everyone unawares.
5. Demographics-- population changes.
6. Changes in perception, mood and meaning.
7. New knowledge, both scientific and nonscientific.

John Stark Associates [35] in their innovation management articles assumed innovation sources in the future as follows (www.johnstark.com).

1. Customers' customers
2. The company's customers
3. In-house and external marketers
4. In-house and external R&D
5. The company's suppliers
6. The company's management
7. Engineering staff
8. Production workers
9. The company's competitors

II. 2 Knowledge-based Innovation

Towards a knowledge-based theory of the firm

Building on Polanyi [54] and Wittgenstein [70], Sveiby [63] [64] defines knowledge as a capacity-to-act (which may or may not be conscious).

Knowledge is dynamic, personal and distinctly different from data (discrete, unstructured symbols) and information (a medium for explicit communication). Since the dynamic properties of knowledge are most important for managers, the notion individual competence can be used as a fair synonym to a capacity-to-act.

People use their capacity-to-act in order to create value in mainly two directions; by transferring and converting knowledge externally and internally to the organization. The value grows each time a knowledge transfer or conversion takes place. The strategy formulation issues are concerned with how to utilize the leverage and how to avoid the blockages that prevent sharing and conversion. Activities that form the backbone of a knowledge-based strategy are to be aimed at improving the capacity-to-act both inside and outside the organization. (Karl-Erik Sveiby, 2001)

A knowledge-based theory for strategy formulation

It follows from the discussion above that strategy formulation should start with the competence of people. Inspired by McLuhan, Sveiby [45] [71] suggests that people in organizations create external and internal structures in order to express themselves. Most "things" in organizations are such relationships. People in an organization can use their competence to create value in mainly two directions: externally or internally. The external structure family consists of relationships with customers and suppliers and the reputation (image) of the firm. The internal structure consists of patents, concepts, models, and computer and administrative systems. These are created by the employees and are thus generally "owned" by the organization. The structure is partly independent of individuals and some of it remains even if a large number of the employees leave.

From an organizational viewpoint the knowledge has effectively doubled. Knowledge shared is knowledge doubled. The key to value creation lies in how effective these communications and conversions are and the major issue strategy for formulation is: how can the leverage be used to create value for the firm? The value creation is primarily determined by the tacit/explicit transfer of knowledge between individuals and in the conversion of knowledge from one type to another [50] as Figure 2-1. Knowledge transfer between individuals tends to improve competence of both individuals and teamwork tends to be a team co-creation of knowledge. However, it helps strategy formulation and action planning to distinguish directional components of the activities. Since knowledge cannot be managed the knowledge strategist looks at enabling [67] activities rather than command-control activities.

According to above, we can distinguish knowledge transfers, which create value for the organization. Enabling activities that form the backbone of a knowledge strategy are to be aimed at improving the capacity-to-act of people both inside and outside the organization.

The external transfer involves intangible relationships with customers and suppliers and forms the basis for the reputation (image) of the firm. Some of these relationships can be converted into legal property such as trademarks and brand names. The value of such intangible resources is primarily influenced by how well the company solves its customers' problems. The internal transfer relates to explicit administrative processes, internal networks, organizational culture and the competencies of individuals. [64]

Knowledge-based theories are the key to explain determined firms' behaviours such as:

1. Strategic alliances [32]; [37];
2. Mergers and acquisitions [6];
3. Firms' internationalisation [34];
4. Diversification [51]; or
5. Production plants' competitiveness [38].

The genesis of knowledge-based competition

Two intertwined strategic forces are compelling companies to reconsider fundamental business assumptions. These are, first, globalization and, second, digitization with connectivity brought about by revolutions in information processing, telecommunication (or infocom) and Internet technologies. These two forces - more aggressive global competition and accelerating technological change - translate into competition that is increasingly knowledge-based. This increasingly knowledge-based nature of competition is driving change in how value chains are being managed within and across firms. Managers will certainly have to augment their ability to manage diversity, complexity and ambiguity in employee, supplier and customer relationships in the New Economy.

The new management imperatives

Driven by these two forces, we are in the midst of an economic transition from an era of competitive advantage based on information to one based on knowledge creation. Today, intangibles such as customer service, innovation, speed, agility, etc. are more important than tangibles such as equipment, materials and hardware. To survive in the knowledge economy, new business models must be created, because many business axioms of the old economy are no longer applicable. Scarcity is a non-issue for digital assets. As such, the competitive dynamics of digital products differ greatly from that of physical products. In cyberspace, new economies of scales and economies of scope prevail [36].

A firm's performance depends on how much its managers can mobilize the knowledge resources individuals and teams in its value chain and how well they can turn these resources into activities that lead to value creation in hyper-competitive markets. Challenges presented by the knowledge economy make it necessary for organizations to harness the competencies of its knowledge workers, customers and suppliers, if sustainable competitive advantage is to be achieved as figure 2-1. [36]

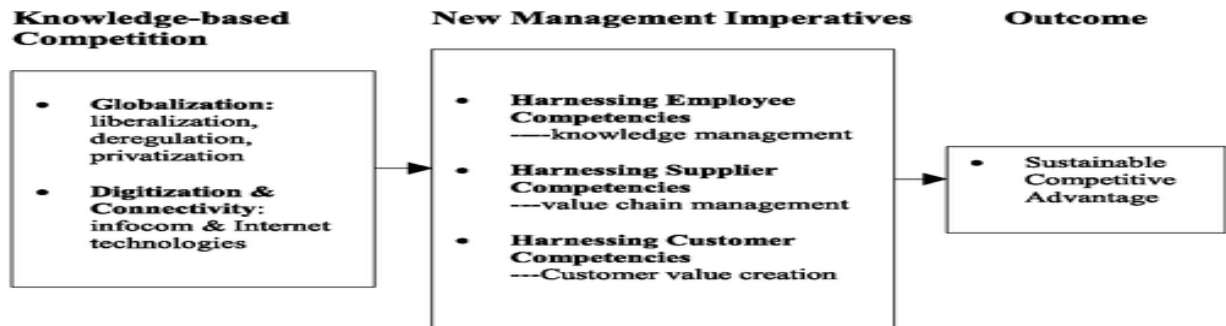


Figure 2-1: New management imperatives Source: [36]

Josephine Chinying Lang, [36] argues that there are linkages between aspects of the New Economy, including globalization and digitization, knowledge generation and competencies. Harnessing worker, customer and supplier competencies within the context of knowledge-based competition is the response called for.

The coming of globalized knowledge-based competition demands that management must attend to its knowledge workers, suppliers and customers in a new way. The real value of information systems lies in connecting people to people to enable them to share what expertise and knowledge they have at the moment, given that cutting edge knowledge is always changing. The solution is not to try to warehouse everything your workers ever knew but to connect questions to answers or to people who can help you find answers.

II. 3 Knowledge and Innovation in High Tech Industry

The study chose Markusen *et al.*'s [42] definition of high-tech, which is based on the percentage of high "human capital" jobs in an industry. High human capital jobs include engineers, technicians, scientists, mathematicians or some combination thereof. By this definition, there are 100% high-tech industries. One of the most important advantages of this definition over others is that human skills highly correlate with other indicators of "technological" performance, such as R&D [4], stock of capital, information intensity and, more importantly for the study, innovations.

In high tech manufacturing firms, the increasing importance of innovation in which knowledge turns into the main source of competitive advantage [47]. The importance of knowledge as a source of competitive advantage is still higher for those sectors on which innovations are being continually developed [18]; [53]. Also, knowledge management is crucial for successful launching of new products [40] and for the innovation process [56]. Therefore, organizations base competition on efficiency when acquiring [50], transmitting and integrating [71] and applying [62] knowledge.

Innovation in high tech firms is progressively turning into a systematic process, especially for determined high tech industries such as electronic products. Specific departments for management of R&D activities are created.

Also, a higher contact with customers increases the role that customers play in the innovation process [14]. Therefore, both R&D departments and customers become the main source of inputs for innovation.

However, innovation patterns in high tech manufacturing is for organizational and process innovations. The impossibility of patenting this kind of innovation and, therefore, protecting the returns generated out of these innovations shortens the life cycle of innovations dramatically [3]. Hence, the innovation process must be intensive because innovations are implemented and copied at such a speed that continuous innovation efforts are required to keep up with a determined degree of differentiation in order to support the firm's strategy [68].

Today, economic competition has become increasingly important in international commerce. High-tech dominates economic competition. Governments around the world realize that only by strengthening technological innovation, possessing their own intellectual properties and grasping high-tech resources can they take the initiative in economic competition. So, technologically advanced countries adopt various policies to protect their intellectual property rights. They try to achieve a market monopoly through a technology monopoly. It is spurring the public to place greater value on knowledge-technological resources. They realize that in the future world knowledge is the most important basis for economic growth. A country's "capability of creation, distribution and use of knowledge" will become the core of its competitive power.

In knowledge-based hyper-competitive markets, sustainability of competitive advantage will depend on a firm's innovative capacity. The rapid creation and diffusion of knowledge within and between firms have thus become a top priority for management, because it is now recognized that knowledge is the only real source of sustainable competitive advantage. That is, a firm's performance depends on how much its managers can mobilize the knowledge resources of individuals and teams in its value chain and how well they can turn these resources into activities that lead to value creation in hyper-competitive markets.

II. 4 Innovation Capacity Link between the Inside and Outside

Elson Szeto [22] assumed innovation capacity refers to a continuous improvement of the overall capability of firms to generate innovation for developing new products to meet market needs (customer needs). The capacity can be incrementally or radically increased through the participation of activities that triggers the supply of innovation resources and conversion of the resources as the knowledge base of the firm in an interactive environment [22]. The interaction is a process that provides stimulation to the firm from external sources that may be convertible into innovation resources.

Internally, a firm can further develop the innovation impulse as resources and apply it to new product development that will be turned into the knowledge base of a firm if appropriate codification is systematically implemented. Externally, inter-organizational network is an environment for the interaction and activities such as joint projects, collaborations or alliances for a specific R&D item and may benefit the participants in various degrees.

"What is unique about the way Japanese companies bring about continuous innovation is the linkage between the outside and the inside. Knowledge that is accumulated from the outside is shared widely within the organization, stored as part of company's knowledge base, and utilized by those engaged in developing new technologies and products" [50].

What "outside" environment is suitable for the development of innovation capacity of firms? Elson Szeto [22] assumed researchers of different perspectives still debate whether innovation can be generated from within firm hierarchy or from within a networked environment. Studies from a network perspective [5]; [23]; [2], inter-organizational network, becoming a new organization form, provides different stimulation through the collaborative activities with network members. Nohria and Ghoshal [49] find that the hierarchical structure of the conventional organization form was inadequate for the shift towards customization of product development and global linkages of product markets.

However, Drucker [20] suggests a systemic analysis of the possible sources to maintain "purposeful innovation" when entrepreneurs start their innovation processes within their resources and Whitley [69] looks for the governance systems that affect firm capabilities in performing various activities. The fundamental issue is how these organizational environments increase and support the firm's capacity of innovation for the continuous improvement of competitiveness, the answers is the internal and external supporting processes of innovation which reviewed as below.

II. 5 The Internal Supporting Processes of Innovation

II. 5. 1 Knowledge Management and Innovation

The innovative efforts are the right consequence of the investment in knowledge and knowledge workers. If KM is positively influenced by the search of innovations, the investments in the development of new knowledge may propel companies into new business in more rewarding

markets.

Innovative efforts have to be strategically combined with a competitive orientation and its consequent movements. This combination depends vitally on the highest level of individual knowledge and on its technological basis. Many companies are taking into account that new technologies and management approaches are changing the traditional perspective of managing intellectual resources. Knowledge acquisition, integration and application etc. knowledge management approaches can facilitate innovation, besides, we also need to consider competitors' knowledge when implement innovation. Improved techniques for knowledge integration lead to higher innovation levels [16].

KM, then, is about harnessing the intellectual and social capital of individuals in order to improve organizational learning capabilities, recognizing that knowledge, and not simply information, is the primary source of an organization's innovative potential [43]; [10]. The objective of KM can be to enhance exploitation (i.e. where existing knowledge is captured, transferred and deployed in other similar situations) or exploration (i.e. where knowledge is shared and synthesized and new knowledge is created [39]. The purpose of exploitation is to reduce problems of "reinventing the wheel" by using existing knowledge more efficiently. Although this is important for innovation, it is largely exploration through knowledge sharing that allows the development of genuinely new approaches.

However, the growing emphasis on innovation through "knowledge work" and "knowledge workers" and on the leveraging of "knowledge assets" suggests that the need to manage knowledge will endure as a core business concern, even if the label may change [20]. This is not to say that knowledge was ever insignificant - what is distinctive about the current period is that knowledge now acts upon itself in an accelerating spiral of innovation and change. Castells [10] summarizes this shift:

What characterizes the current technological revolution is not the centrality of knowledge and information but the application of such knowledge and information to knowledge generation and information processing/communication devices, in a cumulative feedback loop between innovation and the uses of innovation ... For the first time in history, the human mind is a direct productive force, not just a decisive element of a production system.

There are also clearly organizational trends which are aligned to this focus on KM in innovation. In organizational terms, the new "era" is typified by flatter structures, debureaucratization, decentralization, and co-ordination through increasing use of information and communication technologies (ICT). However, as businesses are stretched across time and space, reorganized along process or product lines, and restructured around virtual teams, they lose opportunities for innovation through the casual sharing of knowledge and learning induced by physical proximity.

Gibbons [25] notes further that "modes of knowledge production" are changing from the conventional disciplinary-based model, to a new model where knowledge is

produced interactively at the point of application among heterogeneous groups. In short, innovation processes are becoming more interactive - more dependent on knowledge which is widely distributed - therefore KM is increasingly central. Although the term "KM" may ultimately become another fad, the impetus for it is the profound problems posed by new kinds of organization and innovation.

II. 5. 2 KM, Innovation and Competitiveness

KM and the formulation of competitive strategies

In what concerns dynamic organizations, KM is a valuable strategic tool, because it can be a key resource for decision making, mainly for the formulation of alternative strategies. KM should be able to combine innovation efforts, updated IT, and knowledge development in order to achieve a set of capabilities to increase competitiveness. In fact, when this combination is adequately managed, the company can formulate competitive strategies, which integrate innovative products and new technological weapons to face its competitors [1].

In a fast-changing environment, the competitive advantage of many companies is based on the decision to exploit, to develop the power of knowledge development. To find out and exploit opportunities, companies need to establish the main orientations of KM in order to enlarge their growing possibilities based on innovation and competitiveness. If a firm is entirely aware of the vital importance of these factors, management decisions have to consider a complex background where the knowledge of the clients' needs and preferences and the competitors' strategies is decisively important. Practically, this means that a market orientation includes the concept of competitive orientation [61]; [17]. These considerations are already known and well accepted, but we need to extract from them the logical consequences. A competitive decision should be based on a wide and quite firm support, which shall integrate the different relationships among several types of knowledge. As a consequence, a comprehensive knowledge is the vital ground where competitiveness should be built.

II. 5. 3 Technology Innovation

In a study of 200 firms within the Norwegian IT sector, Johannessen, Olaisen, Bjørn [33] found that focusing on the use of IT might be a promising route for studying the relationship between IT and successful innovations, and between IT and performance. They also found a number of trade-offs between the various performance measures and between successful innovations and performance. Although they were able to find positive effects of IT they argue in favor of developing an information and a knowledge strategy prior to developing an IT strategy. Therefore, IT is only can be an enabler for innovation.

II. 6 Managing and Organizing Innovation

Based on in-depth interviews of 32 CEOs and top executives in leading European organizations, 40 people known

internationally for their ability to achieve and maintain a position among the top performers in their fields, and a "best practice study" of five leading international companies. Johannessen, Olaisen, Bjørn [33] in their innovation study pointed out, there are four entities: 1. Focus 2. Mastery 3. Intensity 4. Integrity in the management level, and four elements: 1. Process 2. Relationship 3. Commitment 4. Belonging in the organizing level. They have argued that creating the innovation-led company may represent a viable solution for coping with the turbulence and complexity of the knowledge economy. In doing so, it needs to focus both on the level of management and on the level of organising.

II. 7 The External Supporting Processes of Innovation

II. 7. 1 Inter-Organizational Network

Flows of knowledge on customers' needs increase the firm's degree of innovation. Need and experiences of customer is the most important source of innovation. Externally, inter-organizational network is an environment for the interaction and activities such as joint projects, collaborations or alliances for a specific R&D item and may benefit the participants in various degrees. When thinking of marketing knowledge, one should think of things such as competition, suppliers, customers, markets, target groups, consumers, clients, users, interested parties, sales, after sales, trade and distribution and relation management. [16]

Knowledge that is accumulated from the outside is shared widely within the organization, stored as part of company's knowledge base, and utilized by those engaged in developing new technologies and products" [50]. What "outside" environment is suitable for the development of innovation capacity of firms? Studies from a network perspective [5]; [23]; [2], inter-organizational network, becoming a new organization form, provides different stimulation through the collaborative activities with network members. The fundamental issue is how these organizational environments increase the firm's capacity of innovation for the continuous improvement of competitiveness.

II. 7. 2 Innovation Network

Innovation processes in a knowledge-based perspective

Due to the increased complexity of modern innovation processes a firm has to master a great number of different knowledge fields. In order to have the necessary access to external knowledge sources, firms, besides their specific competencies, have to provide for an additional broad knowledge base, the so-called absorptive capacity [11]; [8] or receiver competence [21] which allows them to flexibly react on external developments and external knowledge. In the computer industry, for example, the disciplines involved in the innovation process may range from solid state physics to mathematics, and from language theory to management science. So-called go-it-alone strategies or conservative strategies which mean that a firm relies only on its own R&D endeavours, cannot be successful in such a complex environment. Because of the systemic character [31] of

present-day technological solutions, technological development necessarily becomes a complex interactive process involving many different ideas, and their specific interrelationships.

Innovation networks in the knowledge-based approach

Obviously, the above characterisation of innovation processes has significant impacts on the analysis of innovation networks. These networks need to be understood not only in terms of transaction costs considerations, but also in the terms of learning, path dependencies, technological opportunities, and complementary assets. Networks do not only influence the co-ordination of resources but also insert a significant impact on their creation. This has to be seen in a twofold perspective: First, the pooling of different competencies in the network of firms of course enhances this process of resource creation by exploiting complementary effects. However, additionally, the co-operation in networks also creates a real surplus or synergy in this process [7].

In this light networks represent a mechanism for innovation diffusion through collaboration and the interactive relationship becomes not only a co-ordination device to create resources, but an essential enabling factor of technical progress [72]. Here it is not enough just to know what others are doing, but the firms also need to know how the respective technologies function and work together. And to support this inter-firm learning of often long-range cumulative, tacit and local know-how a stable and long lasting collaborative environment is necessary. This way innovation networks offer a possibility to overcome the restrictions of the irreversibilities and instead build on different specific knowledge-bases. With the fusion of different technological capabilities the exploration of new opportunities becomes possible - the cross-fertilization effects. In this respect, the essential dynamic properties of innovation networks become obvious.

Besides this creation of new so-called extensive opportunities [12] which constitutes the synergetic or surplus effect of innovation networks, above also the complementary effects were mentioned. In this respect, it is helpful to recall that the variety of assets and competencies which a firm needs access to in order to successfully commercialise a new technology is likely to be quite large even for only modest complex technologies [66]. Here, innovation networks show to be a promising alternative co-ordination mechanism which allows firm to have access to the complementary assets, which otherwise have to be built up alone - an extremely expansive and time-consuming endeavour, confronting at least small and medium sized firms with often insurmountable difficulties.

Successful innovation requires complex forms of business organisation. Innovating organisations must form linkages to others, upstream and downstream, lateral and horizontal. Advanced technological systems do not, and cannot, get created in splendid isolation. The communication and co-ordination requirements are often stupendous, and in

practice the price system alone does not suffice to achieve the necessary co-ordination [66]. Innovation networks represent such a flexible organisational device.

In summary, there are three major implications within the knowledge-based approach innovation networks: 1. Through accelerating and supporting the diffusion of new technological know-how, they are seen as an important co-ordination device enabling and supporting inter-firm learning. 2. The exploitation of complementarities becomes possible within innovation networks, which is a crucial prerequisite to master modern technological solutions characterised by complexity and a multitude of involved knowledge fields. 3. Through the amalgamation of different technological competencies, innovation networks constitute an organisational setting which opens the possibility of the exploration of synergies. By this, innovation processes are fed with new extensive technological opportunities, which otherwise would not exist, or whose existence would at least be delayed.

Functions and forms of innovation networks

National and regional systems of innovation

An important strand of literature focuses from a national angle on the institutional setting within which innovation processes and the specific interactions between the different actors involved take place. They coined the notions of national systems of innovation [41]; [48] and development blocs [15]; [9].

Formal and informal networks

The design of a specific innovation network can vary on a spectrum between formal contractual agreements and loosely coupled informal networks. Freeman [24], by surveying the empirical literature states:

Although rarely measured systematically, informal networks appeared to be most important. Multiple sources of information and pluralistic patterns of collaboration were the rule rather than the exception.

In this respect, following Hakanson [28], also a dynamic component exerts influence: with an increasing duration of formal R&D co-operative relationships, they mutate to informal relationships as mutual trust and confidence between the partners is built up.

II. 7. 3 E-knowledge Networks

The universal adoption of the Internet has created the opportunity for firms and other organizations to establish collaborative networks of partners, with whom they may exchange strategic knowledge in order to achieve mutually beneficial objectives. This electronic commerce knowledge can be termed "e-knowledge" [29]. These "e-knowledge networks" could not have existed just a few short years ago because there was no widely-accepted platform for continuous and unattended exchange of information and knowledge about markets, customers, demand, inventories, and so forth. Today, such collaborative networks are

evolving in every economic sector in support of business-to-consumer commerce, business-to-business commerce, government-to-citizen interactivity, peer-to-peer exchanges, and internal connectivity through intranets [27]; [44] The technology of the Internet has become the greatest enabler of knowledge exchange within and between companies!

E-knowledge networks combine the positive benefits of knowledge management (KM) systems with those of inter-organizational systems (IOS). They also address some of the pitfalls of each, creating a powerful driver for advancing organizational objectives. Merrill, Ravi, Vijayan, [46] highlights some of the characteristics of e-knowledge networks. When firms engage in e-knowledge networks, they are able to share valuable knowledge, often created with emerging automated technologies such as data mining and intelligent agents, with their strategic partners, thereby enabling improved organizational effectiveness. Furthermore, entirely new business models are facilitated with the development and adoption of certain newer e-knowledge networks. Many of these emerging networks are characterized by automated exchange of rich customer knowledge by unattended computer systems, programmed to capture and evaluate knowledge with data mining algorithms, share it with strategic allies, and direct the operation of key interactive processes.

The keys to success in this evolving new economy are situational awareness and flexibility. These goals can be achieved by implementing electronic systems that generate immediate (real-time) knowledge about internal functions and processes, about customers and markets, about strategic partners, and about supply chain partners - suppliers, vendors, dealers and distributors. Such systems allow firms to be dynamic and flexible, thereby allowing rapid changes in their strategies and activities. Firms can use this knowledge to create new internal and external structures and relationships, leading to further improvements in knowledge, which leads to continuous strategy improvements.

Merrill, Ravi, Vijayan, [46] highlight the exchange of information and knowledge between e-knowledge network partners that are altering the implementation of B2B supply chain practices. These partners, in many cases, are altering their procurement practices to leverage the benefits of rich knowledge exchange for long-term success. They suggest that as the Internet expands its reach, along with ubiquitous and often automated information sharing capabilities, the ability to create knowledge-based networks of partners will be critical to maintaining competitive advantage. Firms will learn to rely on strategic partners for both core and peripheral functions, and will outsource significant processes to organizations who specialize in such functions and activities.

II. 8 The Innovation Supply Chain

II. 8. 1 What is Innovation Supply Chain?

According the definition by Sciquest Company [60], the innovation supply chain is a methodology used to efficiently

integrate suppliers and research-intensive organization to ensure materials and information are made accessible and distributed at the right qualities, to the right locations, at the right time, in order to speed the process of innovation, reduce costs and improve quality. The ISC provide a framework for a seamless, streamlined approach to planning, sourcing and delivering products, As in manufacturing, optimizing the ISC is critical to maximizing throughput and enabling flexibility. ISC introduces intellectual capital, information management and regulatory compliance into tradition supply chain methodology. (www.sciquest.com)

II. 8. 2 How to Achieve the Goal of a Well-Managed Consumer Experience

The innovation supply chain

It is getting harder and harder to satisfy consumers in mature markets like C&EE (Consumer & Electronic Equipment) products, high tech manufacturing margins are being squeezed and competition on price is no longer a valid strategy. Increasingly, across many markets, the driving purchase criterion is the consumer's expectation of the overall experience a product will deliver. Those that do not offer a clearly differentiated experience risk being valued as commodities. A more effective strategy for manufacturers is to not only benchmark on price, or even command a small premium but also differentiates on the basis of consumer experience. In other words, behave like a successful service company. [26]

The use of outside supply may enhance an organization's ability, this focus on consumer experiences represents the ultimate challenge for manufacturers. New products are delivered into the economy by teams of professionals from different disciplines. In some of these - marketing and sales, for example - the knowledge focus is clearly on the consumer. In other disciplines - technical and creative in particular - the knowledge focus tends to be inward, that is, towards the specification of the product.

In the debate, poor knowledge flow, and entrenched uni-disciplinary attitudes emerge as the main barriers to the creation of better - higher margin - products brought to market in the shortest possible time. Shared goals, leading to collaborative effort and planning, seem to be the key to achieving reliable products with good functionality at a realistic price. However, to achieve the goal of a well-managed consumer experience a much higher level of knowledge transfer is needed, between consumer-facing disciplines such as marketing and design towards delivery disciplines such as engineering and manufacturing [26].

To achieve this higher level of integration, the innovation process needs to be seen as a knowledge supply chain - whose efficiency is measured by the extent to which a vision of the target experiences reaches each link in the chain. In parallel, other factors, such as intense price competition, are working to make integration even harder. To achieve maximum efficiency, professionals in different disciplines tend more and more to work for different

companies, often in different countries or on different continents. Commercial and cultural barriers abound. Information technology is helping information flow and is a parallel catalyst for change in the innovation process. However, to achieve any effective change, current underlying attitudes need to be understood and altered if they present an obstacle to progress. [26]

In practice, Gus Desbarats [26] assumed a framework namely "The Innovation Supply Chain" as follows: The problems involved when marketing to consumers in mature markets. Emphasises the need to build a direct knowledge of their consumers and to differentiate the service, product and brand from those of competitors. Asserts that small, distinct service experiences will combine to create a strong overriding impression of quality and value, and this mechanism is the foundation of achieving a strong brand. However, to be achieved in practice, these service targets need to be understood and communicated clearly up and down the innovation supply chain. This involves full co-operation between marketers, designers, manufacturers and distributors.

II. 8. 3 The Elements of ISC

In recent years, innovation supply chain (ISC) has attracted increasing attention as a comparatively mature organizational innovation mode, and this concept is still developing. The 'ISC', has now become a common phrase in daily business life, similar corporations temporality joining together into meta-enterprises, and that of manufacturers, suppliers, distributors and even customers linking together in an enduring relationship built on mutual trust [26]. The innovation revolution is the defining business transformation of our generation." The *Taiwan Economic Daily* [65] held that though ISC can deal with production, sales, design, finance and other functions, enterprises have no such internal organization to carry out these functions. That is to say, the enterprise will not relinquish its key functions. Concerning the rest of the company's functions, due to limited resources and insufficient competitiveness, the enterprise must become a virtual company.

It must use every means to borrow strength from outside to increase its competitive edge. The target of this borrowed strength might be the upstream suppliers or the competition or the customer. Whatever the form, the guiding principles of ISC are to break the limitations of enterprises and extend the scope of the entity by using a strategy called "integration of external resources". This is a break from the former strategy - "selection of internal resources". In general, ISC is a type of dynamic union to respond quickly to market changes. There are 7 elements of ISC as follows [26].

1. The age of collaborative innovation
2. A necessary environment to integrate intellect through various fields for co-operative and inter-organization innovation organizations
3. The era of the knowledge economy, and the age of breaking the boundaries of the old research system

4. The flexible organization to facilitate free flow
5. A collective body to encourage people to learn from each other and share common knowledge
6. A parallel network-type organization and the new concept of "leadership"
7. Combination of relaxing environment and team spirit.

II. 8. 4 Summary

What needs to change and how each discipline helps the collective to deliver better consumer experiences? By examining attitudes along the innovation supply chain, we can see the use of outside supply may enhance an organization's ability to provide a wider product range and to diversify. Quinn et al., [57] pointed out: "Focusing on a narrower range of activities may allow core activities to be more easily levered to achieve a wider product range". In addition, the study proposed: "the total investment required to enter a new business area can be reduced and there can be easier achievement of optimum performance". Suppliers and collaborating partners can assist the innovation process through access to technologies, skills or information [19]; and through providing complementary expertise improve the speed to market of new product developments. In brief, an ISC meets the needs of innovation. It is the inevitable trend of social development.

III. Methodology

First of all, the study through literature review to develop a research framework. Secondly, the study through case studies to develop a more complete and practical integrated model and six researches propositions for practitioners of high tech industries and future researchers.

The data collection was through analysis of secondary data and interviews. The study interviews with top and middle level of directors who are related to innovation and knowledge management in 5 high tech industries. The interview questionnaires are sent out about 20, the response rate is 85%. The interview questionnaires are designed by informal and semi-structure, before send out to these high tech industries, the study have sent out interview questionnaires for pre-test to someone who are related with innovation and knowledge industries.

In summary, the study through literature review to construct a research framework, base on it, the study developed case studies to examine advantage and disadvantage of theories and constructed a more complete and practical model to link theories and practices for high tech industrial innovation.

IV. Case Studies and Discussion

IV. 1 Challenge 2008 - National Development Plan in Taiwan

After joint in WTO and for the new century, current problems facing Taiwan as below:

- Global competition
- Competition in the global economy growing more intense
- Global industrial chains being recognized
- Countries competing for talent and funds
- Mainland China's magnetic effect
- Cheap labor and land
- Vast market and preferential investment measures, luring global capital and technology, and creating industry clustering effects.
- Proposed ASEAN+3 FTA, accelerating the economic integration of China and East Asia.

Therefore, the Executive Yuan formally approved the National Development Plans for the new century on 9, May, 2004, which calls for a total investment of NT\$2.6 trillion over six years in the overall upgrading of Taiwan's living as well as investment and operating environments. The plan to develop a knowledge-based economy in Taiwan. This blueprint for socioeconomic development, with an equal emphasis on knowledge and innovation, economy and culture contains 10 key projects. The study reviews the goals and strategies of which are described below [13]:

- . Cultivation of E-Generation Manpower
- . Establishment of a Base for Innovation and R&D
- . Heightening of Industrial Value
- . Construction of e-Taiwan
- . Development of Operations Headquarters

Four major investments: Personnel, R&D and innovation, global logistics channels, living environment

Challenge Goals: Taiwan World No. 1 in 15 products or technologies, Doubling of tourist arrivals, R&D spending equal to 3% of GDP, Reduction of unemployment to under 4%, Economic growth rate above 5%, More than 6 million broadband households, Creation of 700,000 job opportunities. (<http://www.cepd.gov.tw/service/board/coun-dev.htm>.)

According to above background, motivation and the national development plan, in practice, the study adopts case studies to examine advantage and disadvantage of the integrated model (figure 2-4). After modification, the study constructed a more complete and practical integrated model to link theories and practices for high tech industrial innovation. Finally, the study developed six research propositions for practitioners and future researchers. The study summarizes the results of case studies, interviews and discussion as follows.

SWOT analysis

For comparing and finding out the advantage and disadvantage for these case studies, the study utilizes SWOT to analyze five cases: TK E-Business Corporation, SOYO Corporation, ELSA Technology, Radiant Innovation

company and Global View Corporation as table 4-1 to 4-5.

The results of interviews

The study summarized the results of interviews for case studies as follows:

1. All of firms for these case studies are knowledge-based companies.
2. All of firms for these case studies use technology innovation.
3. All of firms for these case studies are high technology industries.
4. All of f firms or these case studies are cross-strait (multinational) corporations.
5. All of firms for these case studies implement knowledge management and innovation orientation.
6. Some of firms for these case studies implement e-supply chain or knowledge (innovation) supply chain.
7. The ISC could guarantee reliability, flexibility, and scalability. ISC also can help high tech industries to get inter-connected with all relevant parties in the commerce process and extend the reach of business to the global market.
8. All of these firms throughout the world have developed international operation strategies to establish a worldwide production, distribution, and marketing network.
9. A new economic order in China and Taiwan– the globalization of business – has both shaped and been shaped by the advancements in knowledge and innovation management that have improved the efficiency and effectiveness between markets, manufacturing processing, and resources.
10. China's unprecedented economic growth and globalization have strained its knowledge-economy and innovation infrastructure to the limit.
11. Knowledge-based innovation – the movement of technology, people, processes and information – has a significant impact on a society's standard of living. And the standard between China and Taiwan is less and less.
12. A typical "innovation (knowledge) supply chain" may involve a variety of stages that include knowledge suppliers, manufacturers, wholesalers, distributors, retailers and customers. Innovation refers to the knowledge, and the management of the movement of knowledge and information, from one place to another as they make their ways from the beginning of the innovation (knowledge) supply chain to the customers' hands.
13. Efficient innovation management involves a successful integration of knowledge and technology that facilitates the innovative processes of products to the consumers at the right time and right place in accordance with consumer needs. The demand for higher quality innovative management is growing tremendously.
14. If foreign companies encounter too many innovative problems and barriers in China, to the extent that the total costs of utilizing China as a manufacturing base become too high when compared with other nations, then China will be

excluded from a foreign firm's global manufacturing network.

15. The innovation barriers identified in the interviews and case studies include high innovation costs, lack of knowledge integration and innovation infrastructure, the monopolistic nature of innovation management, and the poor quality of knowledge and information flow.

16. These obstacles have been recognized as the most common barriers that foreign and local firms have encountered in China. The integrated innovation model constructed from the case studies aimed at identifying innovation barriers and the solutions to those barriers from a knowledge-based perspective. The knowledge/innovation gaps should be filled in to map a more comprehensive picture of the proposition.

IV. 2 Discussion

IV. 2. 1 Knowledge Based Innovation for High Tech Industry to Fit Global Competition

Many firms throughout the world have developed international operation strategies to establish a worldwide production, distribution, and marketing network under the intensification of global competition. Fast economic growth, low labor costs, and a potentially huge domestic market have all led to significant increases in foreign investment in Mainland China as investments in manufacturing in China are frequently made due to the strategic benefits that they can bring. In near future, China may influence the world as a source of raw materials and an international manufacturing center. Moreover, as a major importer and exporter of consumer products, capital goods, and high technology.

The globalization of business – a new economic order in China has both shaped and been shaped by the advancements in knowledge and innovation management that have improved the efficiency and effectiveness between markets, manufacturing processing, and resources. China's unprecedented economic growth and globalization have strained its knowledge-economy and innovation infrastructure to the limit. Knowledge-based innovation – the movement of technology, people, processes and information – has a significant impact on a society's standard of living. The innovative process affects every sphere of human activity and business strategy.

Efficient innovation management involves a successful integration of knowledge and technology that facilitates the innovative processes of products to the consumers at the right time and right place in accordance with consumer needs. As an increasing number of foreign manufacturers are establishing joint ventures in China, the demand for higher quality innovative management is growing tremendously. The reason for this growth in demand is simple: if foreign companies encounter too many innovative problems and barriers in China, to the extent that the total costs of utilizing China as a manufacturing base become too high when compared with other nations, then China will be excluded from a foreign firm's global manufacturing network.

The innovation barriers identified in the study include high innovation costs, lack of knowledge integration and innovation infrastructure, the monopolistic nature of innovation management, and the poor quality of knowledge and information flow. These obstacles have been recognized as the most common barriers that foreign and local firms have encountered in China. The frameworks constructed from the literature review suggest that little research has been aimed at identifying innovation barriers and the solutions to those barriers from a knowledge-based perspective. The knowledge/innovation gaps should be filled in to map a more comprehensive picture of the proposition. The study through case studies, SWOT analysis and interviews to propose a solution includes knowledge innovation, integrating internal and external processes for supporting innovation to fill the knowledge/innovation gaps and to map a more comprehensive picture of the proposition.

IV. 2. 2 The Greatest Challenge and the Long-term Influence

There should be two aspects: the information condition based on an electronic network and human relationships based on people and organizations in a complete foundation for the development of society, economy and technology should have. It is necessary for ISC systems to assist in the forming and improving of the latter basic aspect.

Changing a mindset is the greatest challenge. China has not yet formed the mechanism to invest in "men". Most people cannot accept the concept of ISC. When you talk about "virtual" organizations, many people, including those who are for so-called organizational innovation and advocate the concept of "advanced organizations", still pay first attention to the organizational scale, administrative ranks and the power and right. Their immediate consideration is not how many results that users or markets will adopt.

IV. 2. 3 Towards the Sixth-generation Innovation Process

The innovation supply chain is a methodology used to efficiently integrate suppliers and research-intensive organization to ensure materials and information are made accessible and distributed at the right qualities, to the right locations, at the right time, in order to speed the process of innovation, reduce costs and improve quality. The ISC provide a framework for a seamless, streamlined approach to planning, sourcing and delivering products. As in manufacturing, optimizing the ISC is critical to maximizing throughout and enabling flexibility.

In short, the study proposed a distinct from the 5G innovation process [59], to summarize the key aspects of the process for ISC and assumed a new KISC (knowledge based innovation supply chain) towards the sixth-generation innovation processes as follows:

- Integration (inside and outside innovation sources; virtual and physical; technology and knowledge; supply chain members; managing and organizing)

- Flexibility (organizational structures; decision making)
- Networking (inter-organization; innovation and e-knowledge networks)
- Cooperation and collaboration
- Quick response (Efficiency and effectiveness); real time information and knowledge processing
- Stability (information and products)
- Maximizing satisfaction (products and services)
- Minimizing cost (processes cost and communication cost)

V. An Integrative Knowledge Based Innovation Model for High Tech Industries

According above literature review, content analysis, case studies and discussions. The study develops an integrative knowledge based innovation model for high technology industries to fit the objectives of the study as Figure 5-1, and describe as follows.

The study integrated customer needs, knowledge-based and innovation networks related theories into a more complete and practical model for high technology industries. Customers (markets) needs are the most important innovation sources, according to customer (markets) needs and knowledge, high tech industries could develop innovation capacity. The core of the model is innovation capacity (supporting by internal and external processes). If high tech industries want to reach sustainable competitive advantage through innovation, it is necessary to integrate internal and external innovation supporting processes due to markets (customers) needs and finally through KISC (knowledge based innovation supply chain) to reach continue innovation and create sustainable competitive advantage for high tech industries.

V. 1 Knowledge Based Innovation Supply Chain (KISC)

KISC gathers people from different fields and technological backgrounds and organizes teams according to specific goals and systems to create superior environments for inter-organization innovation and integration of knowledge and intellect. For creating a more flexible, versatile, faster and robust innovation organization, the study integrated and presented an knowledge based innovation supply chain (KISC) model for integrating and determining innovative supporting process in high tech industries and applying to cross strait (Chinese and Taiwan) marketplace. High technology industries should use KISC perspective for easy and innovative knowledge sharing and flowing.

A new KISC (knowledge based innovation supply chain) as follows:

- Integration (inside and outside innovation sources; virtual and physical; technology and knowledge; supply chain members; managing and organizing)
- Flexibility (organizational structures; decision making)
- Networking (inter-organization; innovation and e-knowledge networks)

- Cooperation and collaboration
- Quick response (Efficiency and effectiveness); Parallel (real time) information processing
- Stability (information and products)
- Maximizing satisfaction (products and services)
- Minimizing cost (processes cost)

V. 2 Research Propositions of the Study

According this integrated innovation model, the study to integrate internal and external innovation processes, and through ISC to make corporate innovation capacity to reach real performances and to reach sustainable competitive advantage. Also, the study proposed one main research proposition and six sub research propositions for future researchers as follows:

RP: High tech industries increase innovation capacity and reach sustainable competitive advantage through linking corporate internal and external innovative supporting processes.

P1: High tech industries according to sources and flows of knowledge on customers' needs to increase the firm's innovation capacity.

P2: High tech industries improve techniques for knowledge management and use technology innovation can lead to higher innovation levels.

P3: High tech industries use managing & organizing approaches can lead to higher innovation levels.

P4: High tech industries apply cooperative innovation with suppliers, customers and partners to increase innovation capacity and lead to higher innovation levels.

P5: High tech industries apply KISC to cooperate with supply chain members, to cultivate innovation capacity and to integrate internal and external supporting process of innovation

P6: High tech industries combine internal and external supporting innovation processes to lead to innovation capacity and through KISC to reach sustainable competitive advantage.

VI. Conclusions

Under knowledge economy, which management approaches and technologies are necessary to support innovation in the knowledge intensive industry especially are high technology industries? It's necessary to integrate internal and external supporting innovative processes for high technology industries. The core is innovation capacities for reaching continue innovation, Internal supporting processes include the knowledge management & technology innovation and Managing & organizing innovation, external supporting processes include knowledge from customers, suppliers, partners and competitors and cooperative innovation. Knowledge management plays a fundamental role when managing processes innovation efforts. Process innovations remain a source of competitive advantage in the market for short periods of time. Knowledge management policies are the main drivers of process innovation. Design of new

processes innovation delivery system must take into account possible customers' behaviors and perceptions. Therefore, the more flexible and versatile knowledge management policies are, the faster and more robust innovation efforts are.

For creating a more flexible, versatile, faster and robust innovation organization, the study presented a knowledge based innovation supply chain (KISC) model for determining innovative supporting process in high tech industries and applying to cross strait (Chinese and Taiwan) marketplace. Such a model is developed under the knowledge-based theory lens. High technology industries should use KISC perspective for easy and innovative knowledge sharing. The study examines the notion that China's and Taiwan's entry into the WTO and its innovation reforms in line with globalization have a significant impact on the entire system of knowledge-based innovation management.

The study describes a complete and practical integrated innovation model. Such a model is developed under the knowledge-based theory lens. So, knowledge flows and knowledge integration capabilities of the organization's members are considered as crucial for the innovation processes to be successfully implemented. Final conclusions consider customers (markets) needs as the most important sources of innovation. And to integrate internal supporting innovation processes (knowledge management & technological innovation and Managing & organizing innovation) and external supporting innovation processes (knowledge and innovation from suppliers, partners, competitors and customers) and cooperative innovation as the main impellers of high technology industrial innovation. According this integrated innovation model, the study proposed one main research proposition and six sub research propositions for future researchers and practitioners. Whether which kinds of innovation are based on knowledge and people (knowledge workers). The winning companies of this decade will be those which provide their people with the best weapons with which to compete, that are knowledge and innovation. The results of the study will benefit not only the construction of knowledge based innovation framework, but also the business model transformation of competitive advantage.

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Table 4-1: SWOT analysis of high tech industries (Case 1)

S	With the collective knowledge and resources of TK's experienced management team who worked for IBM [30], Andersen Consulting, McKinsey Consulting, Intel, Microsoft, Rockwell, Merrill Lynch and vertical industries. TK can acquire strong source of innovation and utilize their expertise of knowledge-based innovation into e-business markets.
W	The major shareholders include China Development Industry Bank, Ta-Jung Logistic Corp., the affiliate of the renowned Hsin Kuang Group, and many other key industry leaders. But lacks of professional marketing channel and supply chain will form a weak situation which let competitors easy to occupy market shares.
O	The large potential benefits between China and Taiwan e-business and e-supply (B2B2C) markets is TK's future opportunity to compete in cross-strait and global markets.
T	The threat for TK is global industries' competition, hard to overcome the block of current technology policy and law from Taiwan government and the lack of protection for intellectual and patent assets from China governments.

Table 4-2: SWOT analysis of high tech industries (Case 2)

S	In this competitive market place, SOYO's strategy to succeed is by continuing to innovate and always position SOYO ahead of the curve. SOYO's contract Research and Development team constantly searches for the latest technology and creative ways to integrate into their motherboards in order to meet the high demands of customers. Knowing their customers is the company's key strength. Launching the right product at the right time is what SOYO believes to be crucial in staying competitive. Best Overall Service. To service its valued customers and to support their needs, SOYO has built a worldwide network of offices. From prompt order processing, speedy and reliable delivery to after sales customer care, SOYO is with its customers every step along the way. The customers are the keys to SOYO's success.
W	SOYO's sales channel in China and Taiwan is still not enough to occupy the popular PC markets. Besides, though SOYO's strategic alliances partners include global famous corporation but SOYO can't get prompt technology transfer from them. This will cause SOYO's innovative product to be delayed time to markets.
O	The SOYO brand is synonymous with quality and creativity, and it is SOYO's goal to continue to grow in today's market place. Through constant search for the newest and the latest and SOYO's ability to deliver products at levels never seen before, SOYO continues to be the industry leader. Their flexible management structure allows SOYO to respond to the market demand quickly. SOYO's goal is to be the best at what it does and to always stay ahead of the curve!
T	1. China and Taiwan's channel competitors. 2. Price's and quality's competition from the other motherboard's famous brand corporations. 3. Global industries' competition and hard to overcome the block of current technology policy and law for Taiwan government and the lack protection of intellectual and patent assets for China governments.

Table 4-3: SWOT analysis of high tech industries (Case 3)

S	ELSA not only benefits from this central location at the heart of Taipei, but also from the steady stream of highly qualified engineers from this internationally renowned university. Short development cycles and innovative products based on ATI and nVidia core technology remain the cornerstones of their continued growth.
W	Elsa has divided the product lines once again into individual business units directly in the heart of the technology hotbed, in Germany and Taiwan. But lack of China markets. As the link between the markets and the company, the business units are responsible for developing attractive product and marketing strategies tailored to the users within the given market segment in their respective regions. But no significant segment in their respective regions. ELSA also lacks of e-supply chain to link their branches and to link from users and distributors.
O	ELSA's presence on international markets is one of the major factors which will determine their future growth. ELSA's presence in Wuerselen (Germany), Taipei (Taiwan), Seoul (Korea), and Beijing (China) play a key role in the development of international markets with their support in regions that are vital to the industry. ELSA regards the European and Asia as decisive markets not only with regard to procurement, but also for future sales and services. Therefore ELSA has been expanding their sales network and they are currently successful in the distribution business for graphics and multimedia products. ELSA Technology in Germany completes the goal of securing a pan-European presence for ELSA complete product range. ELSA expects to increase its support and services significantly. The existing and new relationships with distribution partners will also strengthened through the presence.
T	The existing and new other distribution partners will form threat to ELSA. Global industries' competition and hard to overcome the block of current technology policy and law for Taiwan government and the lack protection of intellectual and patent assets for China governments.

Table 4-4: SWOT analysis of high tech industries (Case 4)

S	Radiant has obtained ISO 9001 and EN46001 certifications. The IR Ear Thermometer, their first product, has been EU CE and USA FDA certified. Radiant has two solid shareholders Sunplus a very experienced IC design company, and Global View, a leading palm-size electronic dictionary manufacturer. With the aim of providing better customer satisfaction, Radiant designs and creates uncompromised quality PHC products with competitive pricing.
W	Radiant lack of strong sales channel in China this most population markets. Also they lack of good channel relationships to promote their products.
O	The trends for aging society and quality living, PHC products have become necessities of life. Radiant will be continuously introducing a series of top PHC products in the near future. Through Radiant steady investments, innovative R&D, and the quality of production, they will become a world class PHC supplier.
T	Radiant are also seeking for ODM and OEM partners around the world. This will cause patent problems and other competitor's imitation. Global industries' competition and hard to overcome the block of current technology policy and law for Taiwan government and the lack protection of intellectual and patent assets for China governments.

Table 4-5: SWOT analysis of high tech industries (Case 5)

S	Ongoing Innovation, Contribute value to Society, Corporate Philosophy, Integrity Innovation Quality Service. Corporate Culture, Business and Customer Oriented, Speed and Simple, Respect, Team Work, Open-Mind discussion, Entrepreneurship
W	At present the company has subsidiaries in Mainland China, Korea, Taiwan, and Hongkong, with more than 1500 employees. But they lack of knowledge base innovation team. Also, they lack of strong marketing channels.
O	With their world-class high-tech know-how, they are committed to LINUX operating systems and GV OS Technology Platform in order to provide clients with powerful and economical overall solutions to software and hardware.
T	The low price competition from China and Korea. The high technology innovation competition from HK. And Taiwan. Global industries' competition and hard to overcome the block of current technology policy and law for Taiwan government and the lack protection of intellectual and patent assets for China governments.

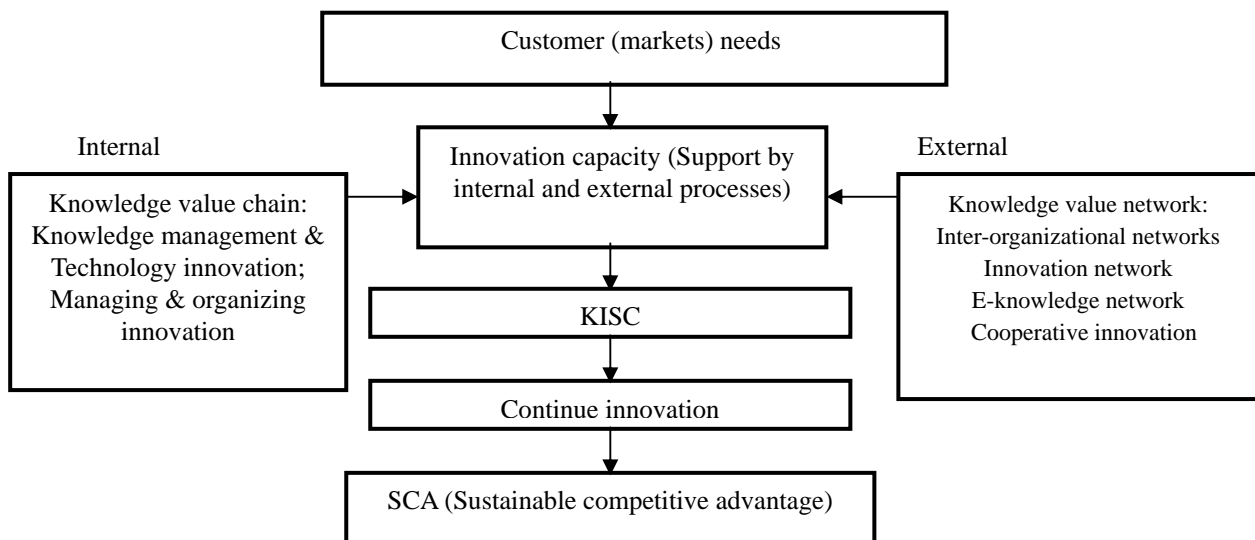


Figure 5-1: An integrated model of knowledge-based innovation for high tech industry

Effective Knowledge Representation Through Data Modelling Approaches

Mik Kim¹, Wusheng Zhang²
Centre for Hospitality and Tourism Research¹
Centre for International Corporate Governance Research²
Victoria University, Melbourne, Australia
Email: mik.kim@vu.edu.au wusheng.zhang@vu.edu.au

Abstract: Data modelling can be seen as knowledge representation in terms of sharing the same philosophical assumptions. In data modelling process, the recognition of the philosophical background on human inquiry and the nature of knowledge pertinent for appreciating the problems is important as different ontological views lead to different conceptions about data models. Recognising and incorporating different forms of organisational knowledge are also important in the data modelling process as a formal representation of some subset of the knowledge, which the organisation needs to carry out its business. This paper discusses the two distinct philosophical foundations for the effective representation of organisational knowledge.

I. Introduction

Information systems with information technology have played an important role in capturing, storing, sharing and disseminating organisational knowledge. In the information systems development stage data modelling is an indispensable part of managing organisational knowledge in describing, organising and analysing data that are stored and manipulated in the information systems. Data modelling is an approach that is used to manage complex problems [6]. Data modelling approaches are divided into two paradigms. They are objectivism and subjectivism. Objectivism in data modelling follows the empirical analytical scientific method. It assumes that reality can be described by independent facts, which corresponds to the empirical base of observational statement in objectivist philosophy. A database captures these facts and data models provide the structure for organising all the facts into a consistent picture of reality. In accordance with this, objectivist data modelling approaches were called fact-based.

In contrast, subjectivism of data modelling pursues subjectivist paradigm. It assumes that the domain of inquiry is not independent of the observer, and therefore reality cannot be described in terms of independent fact. Rather, what counts as reality are socially constructed images, which emerge in social interaction, in particular through communication in some language. The details of these images are not completely arbitrary, but depend on the grammar, the rules and meanings, which govern social communication. Accordingly, a data model attempts to formalise some of the informal social rules and meanings.

The subjectivist data modelling approaches were called rule-based.

As Klein and Hirschheim claim that “no data modelling approach can avoid philosophical assumptions because data modelling is a process of inquiry that has intrinsic similarities with classic scientific theory construction” [12, p. 8], understanding philosophical basis is essential to data modellers because different ontological views lead to different conceptions about data models. It is therefore significant for data modellers to be aware of different philosophical assumptions of conceptual data modelling. The purpose of this paper is to explore the implication of two different objectivist and subjectivist’s paradigms to conceptual data modelling process to effectively represent organisational knowledge. The organisation of the paper is as follows. First it discusses a philosophical perspective on data modelling in general. After that it moves to two sets of assumptions of data modelling in terms of ontology and epistemology. Following the discussion of the two assumptions, it examines objectivist-subjectivist data modelling. Then, it speculates the fact-based and rule-based of data modelling. Finally, it ends with conclusions and future work.

II. Philosophical Perspectives on Data Modelling

There is a slight difference between data modelling and conceptual data modelling. Conceptual data modelling is the phase of the development process that involves the abstraction and representation of the real world data pertinent to an organisation [2] whereas data modelling is the activity of creating a data model. Olle [14, p. 46] points out, “A data modelling facility has to be seen as functionally more restricted than a conceptual modelling facility”. He also points out that conceptual modelling is much less widely used and a data modelling facility is restricted to data and the processes. Although there are discrepancies, in this paper the term data modelling and conceptual data modelling is used interchangeably.

There are linkages between the concerns of data modelling and philosophy. One result of the philosophical debate on the meaning of language and hermeneutics is that it is impossible to capture knowledge simply in terms of articulable facts as the positivists had claimed. A broader concept of knowledge is relevant for understanding practical difficulties with determining the system or formalisation boundary in specifying computer applications. It is widely

recognised that data modelling should include the meanings and relationships among data that may be hidden from the users. It is for this reason that concern for the adequate recognition of the importance of tacit knowledge arises. Tacit knowledge is personal knowledge that is hard to formalise or articulate [15]. Hidden meanings and knowledge can be imperfectly represented during data modelling as it falls within the domain of tacit knowledge.

Moreover, just because users may know how to do their work, it does not follow that it is possible to capture their knowledge in explicit rules and descriptions [16]. This remains true even if some of the users are asked to participate the information systems design teams. In this sense it may be said that data modelling involves the design of a knowledge representation schema, which needs good techniques to decide what to include and what not to include, understanding the important role of tacit knowledge. In addition to the problem of hidden and tacit knowledge, data modelling constructs a formal representation of some subset of the knowledge, which the organisation needs to carry out its business.

Data modelling and knowledge representation can be seen essentially similar in terms of sharing the same fundamental assumptions. The existing approaches of data modelling with regard to the assumptions are about the nature of reality and the nature of the knowledge captured in a data model including the ways and means of how it is collected. That is the paradigmatic dimension of objectivism-subjectivism. The objectivist-subjectivist dimension of a paradigm raises two issues such as one dealing with ontology and the other with epistemology of data modelling.

III. Ontology V Epistemology

Ontology is concerned with the essence of things and the nature of the world. It subsumes two extreme positions of realism and nominalism. Realism postulates that the universe comprises objectively given immutable objects and structures [12]. These exist as empirical entities, on their own, independent of the observer's appreciation of them. On the other hand, nominalism is where reality is not a given immutable out there, but is socially constructed [12]. It is the product of the human mind.

The ontological question what is being modelled points to the fundamental assumption of data modelling approaches about the environment or modelling domain. That is about the nature of the Universe of Discourse (UoD). There are many forms of terminology for talking about the ontology of data modelling. Examples of terms used to describe ontology in data modelling are entities, relationships, facts and speech acts. The ontology of data modelling also includes some fundamental assumptions about the nature of the application domain. That is whether there is a single or several user systems or no system at all, whether the primary constituents of each user system are operations, roles, decisions, social action or speech acts.

In contrast to ontology, epistemology is the grounds of knowledge. The term relates to the way in which the world may be legitimately investigated and what may be considered as knowledge and progress. It includes elements concerned with sources of knowledge, structure of knowledge and the limits of what can be known. Two extreme positions are positivism and interpretivism. According to Klein and Hirschheim [12], positivism implies the existence of causal relationships which can be investigated using scientific method whereas interpretivism implies that there is no single truth that can be proven by such investigation. Different views and interpretations are potentially legitimate and the way to progress is not to try and discover the one correct view but to accept the differences and seek to gain insight by a deep understanding of such complexity.

The epistemological question why the result is valid points to the fundamental assumptions that are made on how one can obtain valid interpretations and knowledge about the UoD. Experimental modes of schema construction like prototyping can be compared with the blue-print specification approach as is associated with many versions of the so called waterfall model of schema development [9][3]. The question of how to cope with different types of uncertainty such as problem during data modelling is not the only consideration that is important in comparing experimental or specification approaches, but it is a good example to demonstrate that different methods imply different assumptions about knowledge and inquiry.

In the context of data modelling, ontological assumptions are concerned with the nature of the UoD to be modelled. Epistemological assumptions are concerned with the appropriate approach for inquiry regarding what one needs to know to create the data model and with the cognitive status of the result is a data model true or it is merely an imaginary tale. That is a simplifying design assumption presumed to be valid only for a particular system at a particular time. The existing approaches of data modelling with regard to the assumptions are about the paradigmatic dimension of objectivism versus subjectivism.

IV. Objectivism V Subjectivism

Objectivism postulates that the UoD is comprised of immutable objects and structures that exist as empirical entities. In principle, a model of the UoD ought to exist which is correct independently of the observers' appreciation of it. A data model is true if it accurately depicts the underlying reality of the UoD. In contrast, subjectivism in data modelling holds that the UoD is a subjective construction of the mind. A data model can best reflect peoples' conventions or perceptions that are subject to negotiated change. Important mechanisms by which subjective experiences take on an objective quality in the minds of individuals are the rules surrounding institutions, tradition as transmitted through artefacts and changing use of language and sedimentation [1]. Sedimentation refers to

the ordering of experiences, which is transmitted subconsciously by virtue of growing up in one segment of society as opposed to another or in different societies altogether [12]. From this view a data model is correct if it is consistent with the perception of the UoD as constructed by institutional programming, sedimentation and tradition. On the contrary, the objectivist view holds that language neutrally depicts reality, which is the same for all regardless of culture and individual perception.

Burrell and Morgan [4] describe the categorisation of assumptions on objectivist/subjectivist and order/conflict dimensions. According to them, the objectivist position is characterised by the realist ontology and positivist epistemology. The objectivist assumes that objects and structures exist as empirical entities independent of human observers and that the appropriate way of acquiring knowledge of the world is by observation and the identification of causal relationships. The subjectivist position holds that scientific method is not appropriate for explaining the social world as different people interpret the world in different ways and any agreement is intersubjective. The appropriate way to investigate the social world is to recognise multiple realities and to adopt an interpretivist stance. The order view of the world sees order, stability and integration while the conflict view sees coercion, disintegration, and places an emphasis on change.

The two classifications organise four particular positions such as functionalism (objectivism/order), radical structuralism (objectivism/conflict), social relativism (subjectivism/order), and neohumanism (subjectivism/conflict). The metaphors of doctor, warrior, liberal teacher, and emancipator respectively have symbolised these groupings. The doctor, technical expert sees data modelling as an objective use where entities and relationships can be said to exist independently of people. The data model is a value-free reflection of a singular reality and scientific method is the appropriate way of building a data model. The warrior also perceives data modelling as an objective use, but assumes that there are conflicting interests and is therefore concerned with whose requirements are being addressed. The difference is that the warrior considers data model as a reflection of real world structures but because of socio-economic factors the data model is not value-free which requires the data modeller's support in the struggle against the owners.

The liberal teacher, facilitator considers reality to be socially constructed and that there are as many realities as there are people involved in the development exercise. A good data model is one, which creates a shared understanding so the appropriate way to go about creating such a model is through participation and facilitation. The emancipator would also consider that reality is socially constructed, but recognises the presence of conflict and hence the exercise of power. The emancipator adopts a critical stance and seeks to initiate change that will improve the situation, recognising that there is unlikely to be a consensus and that any data model will be mediated through

the exercise of power. A good data model is one, which helps create a social reality that eases cultural domination via a rational discourse that is free from restrictions.

Under a more radical interpretation of the subjectivist approach, data modelling does not merely reflect social consensus perceptions, but it affects the very process of reality construction. This is so because socially transmitted concepts and names direct how reality is perceived and structured. The construction of reality varies with different languages and cultures. As data modelling typically introduces new concepts and ideas in the users world, it intervenes with the very definition of what counts as reality. It changes what is subjectively experienced as an objective reality and its appreciation what may at one point have been accidental or not even noticed may become very important and recorded in detail. In this sense, data modelling is a form of institutional representation and once a data model has been in use for some time it may become part of sedimentation and tradition. Accordingly, data modelling is never neutral, but rather a biased supporter of reality.

The framework of the categorisation suggested by Burrell and Morgan [4] illustrates that is but one way of approaching the world in assuming that a good data model is one that mirrors reality we are working within a positivist tradition. There are more frameworks proposed that show what the measure of a good data model is. Berger and Luckman [1] suggest a framework where subjective meanings become objective objectivation that then act back as they socialise present and future generations. Reality construction is the dialectical relationship of these three moments. Giddens's [8] proposal has advanced much complementarily from the paradigmatic conclusion of the Burrell and Morgan [4] by conceiving the objective and subjective to be present simultaneously, as represented in structuration theory. An important implication of structuration theory is that the objective/subjective distinction should be seen as duality rather than dualism, and that it is not possible to separate out objective components. This may lead to some inconsistencies in their conceptual base. Such inconsistencies are often not reflected, because technical work in the area of data modelling is often unaware of the deeper stipulations and assumptions on which newly proposed methods and tools rest.

Those assumptions are the principles on fact based, rule based, and frame based approaches. Objectivism in data modelling follows the empirical analytical scientific method. It assumes that reality can be described by independent facts, which corresponds to the empirical base of observational statement in objectivist philosophy. A database captures these facts and data models provide the structure for organising all the facts into a consistent picture of reality. In line with this, Objectivist data modelling approaches were called fact-based. Subjectivism of data modelling, in contrast, pursues subjectivist paradigm. It assumes that the domain of inquiry is not independent of the observer, and therefore reality cannot be described in terms of independent fact. Rather, what counts as reality are socially constructed

images, which emerge in social interaction, in particular through communication in some language. The details of these images are not completely arbitrary, but depend on the grammar, the rules and meanings, which govern social communication. Hence, a data model attempts to formalise some of the informal social rules and meanings. The subjectivist data modelling approaches were called rule-based.

V. Fact-Based V Rule-Based Data Modelling

The fact-based approach is grounded on concepts that are related to given facts in the sense of existing state of affairs. The fact-based approaches to data modelling tend to follow the objectivist tradition. A fact is typically defined by associating a specific attribute or relationship to a given entity. Under this interpretation, a data model is like a mirror or picture of reality. Reality is a given and out there. Typical examples for such concepts are entity, property/attributes and relationship. Entities have properties or attributes. Both entities and their properties have an objective existence. Entity-based approaches implement von Wittgenstein's [17] picture theory of meaning. That is data correspond to facts and it is these that entity-based approaches seek to model. This is apparent when Kent [11] comments that by focusing on the facts, we obtain a methodology for data analysis and design which is at once simpler and more powerful than other methodologies for data modelling.

The fact-based approach represents the mainstream of the data modelling field. It has the longest history, and it has been intensively researched over the last two decades [5]. The approaches suggested within this approach have been widely applied, and there exists a considerable amount of application experience. Therefore, the fact-based approach is better understood than that of the rule-based approach.

In contrast, the rule-based approaches to data modelling are heavily influenced by the subjectivist tradition. Their proponents see the main task of data modelling as formalising the meaning of messages that are to be exchanged among a professional community such as managers and engineers. The expression of meanings must follow social determined rules, which facilitate the comprehension of what is communicated. They argue that meaning is created within the human mind and related to human purpose or intentions. The latter arise out of an understanding of reality, socially constructed. That is it emerges from social interaction conditioned by social conventions or rules. For example, all computer data ultimately have to be interpreted in terms of their natural language meanings. Hence data can at best convey meaning from someone, but they cannot have any objective meaning.

In the rule-based approach a data model describes rules which govern the uses of signs and symbols in organisational behaviours and thereby attach specific meanings to the organisational vocabulary. Therefore these approaches are largely derived from the concept of a rule. In general, a rule is regarded as a general prescription that

governs the generation, meaning and use of linguistic expressions both informal and formal as are included in the information system.

Rule-based approaches form a minority position in the data modelling field. It has been pursued by few researchers [8] and its history can be dated back to the late 1970s and early 1980s. Rule-based data modelling methods are much less developed than their fact-based counterparts. Moreover, these approaches have not been widely applied in their full form outside academia and experience of their usefulness is limited. One reason for this is their inner complexity and highly developed theoretical vocabulary which is difficult to adopt for practising information systems professionals. Data modelling in the rule-based is an important medium for organisations to learn about their communication practice helping detect distortions and inconsistencies in communication.

There is a third approach on data modelling which combines both objectivist and subjectivist principles of data modelling. The approach is also called frame-based because ideas can be captured in mental frames. The basic modelling construct of an object builds on the concept of an imaginary actor as originally proposed by Kay [10]. An actor in Kay's sense is any software object that behaves in predefined ways. Actors can be used to model real objects, but they can also be used to modelling imaginary objects that represent people's ideas, which exist only in Alice in Wonderland. An actor or frame view of data is based on the idea that a description of data with its permissible operations should be combined into an actor or knowledge frame. The frame-based approach is best viewed as a variant of objectivism in data modelling.

Similar to the frame based approach for the purpose of lessening the danger of one perspective only data modelling, an unbounded systems thinking approach as the application of multiple perspectives to data modelling has been proposed by Mitroff and Linstone [13]. The core three perspectives include organisation (O), technical (T) and personal (P). The T perspective is concerned with a scientific world-view, logic, rationality, modelling and analysis claiming of objectivity. The O perspective is concerned with social entities, politics and processes; and the P perspective is of the individual and concerned with power, influence, prestige, learning and beliefs. The flaw of the approach is associated with practical difficulties by realising different forms of knowledge, which requires different knowledge interests and thus need to be considered jointly. In other words, people with different background and tradition tend to follow one particular perspective over other perspectives for which there are no simple rules for balancing the requirements of different perspectives.

A central issue of data modelling is in assuming that data modelling must be either objective or subjective such that data modelling process can be based either upon the notion of an objective reality or upon the notion of a reality that is socially constructed. In other words, the problem is not whether to be objective or subjective but that one implies the

other and that any method that is based upon one of these ontological positions must accept and cater for the other. Both objective and subjective aspects are present at the same time. Objective methods can be said to be objective because they are not subjective. However, taking a strong objectivist position is difficult. We cannot demonstrate the existence of an objective reality. A strong subjectivist position is another danger for good data modelling. In addition, the failure of information systems development is caused by overlooking many different forms of organisational knowledge. That is beyond of technical aspects. Accordingly, data modelling process should be done by recognising and incorporating the different forms of knowledge, which may influence the success of the entire data modelling process.

VI. Conclusions And Further Study

Data modelling as an organisational knowledge representation is concerned with the fundamental assumptions. The existing approaches of data modelling with regard to the assumptions are about the nature of reality and the nature of the knowledge captured in a data model. In data modelling process the recognition of paradigmatic dimension of objectivism-subjectivism is important. However, it is not appropriate to consider the data modelling process as objective the notion of an objective reality, or as subjective the notion of a reality that is socially constructed. Without the notion of objectivity the notion of subjectivity is meaningless. It should be noted that the sharp distinction between fact-based and rule-based data modelling approaches is not necessary. Although the major emphasis in the information systems research community has been on the fact-based approaches, data modelling processes need to incorporate some of both fact-based and rule-based approaches and thereby engage in some middle ground between the extremes of fact-based and rule-based. For the effective representation of organisational knowledge, consideration should be given to casting both objectivism and subjectivism as a duality. In addition to taking the duality into consideration, data modelling process should also be done by recognising and incorporating different forms of organisational knowledge. The typical response to the problem of tacit knowledge is the modellers' purpose in applying a data model as a formal representation of some subset of the knowledge, which the organisation needs to carry out its business. Misunderstanding is connected to the failure to understand the important role of tacit knowledge. There is a need for good techniques to decide what to include and what not to include in the subset.

Further study should, therefore, include developing applicable techniques for decision making in selecting organisational tacit knowledge. It should also consider in the area of rule-based approaches of subjectivism, as the concepts of the subjectivist approaches are not well researched in comparison with the fact based objectivism. Moreover, although the fact-based approaches are a lot better researched there is more study needed in terms of

development of data modelling approaches that embed the philosophical assumptions.

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The Building of a Knowledge Portal for Supply Chain Co-Evolving

Chian-Hsueng Chao

Department of Information Management, National University of Kaohsiung,
Kaohsiung, Taiwan, ROC
cchao@nuk.edu.tw

Abstract: Today, companies are demanding more than just access to data. They want processed and refined information that will help them to reach more effective tactical decisions. With the global deployment of computers, inter-connecting network, mobile devices, and information architecture, participants can work collaboratively by sharing networked resources, and exchanging knowledge in order to improve corporate performance. The collaboration/cooperation feature is especially important in today's supply chain practices. Under this paradigm shift, information-oriented productivity depends on the sharing of knowledge and skills among workers. Therefore, supply chain strategies can be driven by the collective intelligence and competence to meet today's business challenges that enable organizational learning. Management of organizational knowledge for creating business values and generating competitive advantages is critical for organizational development. In other words, it is related to the efficient integration of enterprise system, e-business application framework, and knowledge portal in order to achieve the goal of a learning organization and a supply chain. co-evolving This paper focuses on the design of an enterprise knowledge portal in a supply chain scheme for today's business. The ultimate goal is to develop a technological framework for a knowledge network that brings people, information, technologies, business processes, and organizational strategies together to better utilize knowledge in e-business. The benefits of knowledge portal in today's e-supply chain collaboration will not only expand the learning capabilities of workers. It will also help supply chain trading partners to develop a more concrete vision and strategy for enhancing their market values.

I. E-Business Supply Chain Knowledge Management

Traditional business partnerships are changing in response to technology advancements and business innovations. Companies can achieve a business advantage by leveraging networking technology and the principle of supply chain integration. With network connectivity, supply chain integration is now the core strategic competence that enables many companies to act as one. Supply Chain Management (SCM) evolved several decades ago from a simple set of logistics performance tools to an inter-enterprise, and even channel-wide, operating philosophy. SCM is now a bounda-

ry-spanning, channel-unifying, dynamic, and coevolving philosophy of inter-enterprise management. The major contribution of today's supply chain model is to improve the bottom line by enhancing collaboration between businesses and their trading partners [1]. This feature is very important for the every industry, because many participants need to cooperate/collaborate intensively throughout a project life cycle, which will change from one job to another.

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. The selection of processes and cooperations with supply chain partners is critical to the success of business. The selection of e-supply chain partners extends beyond choosing a trading partner or contractor and must include configuring the business-to-business collaboration among the partners. An increase in horizontal integration synchronizes the output of the entire supply chain. In today's e-business, competing for supply chain requires either aligning one's strategy to what the organization knows or developing knowledge management (KM) capabilities to support a desired supply chain strategy (Figure 1). Management of organizational knowledge for creating business values and generating competitive advantages is critical for organizational development. Knowledge management systems should support people to access and learn from past and present organizational business practices/strategies and to apply the lessons learned

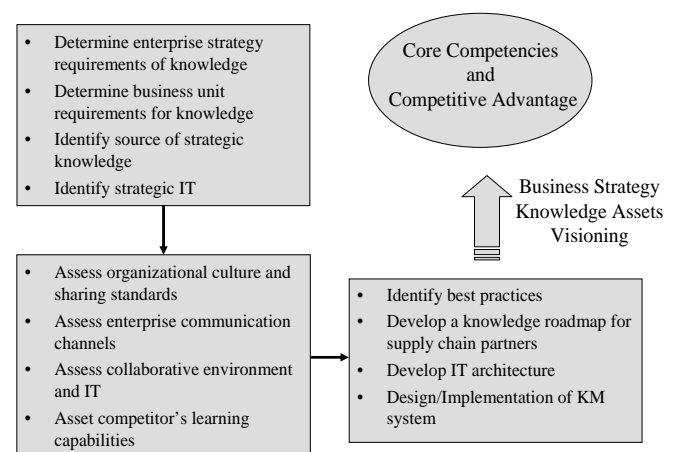


Figure 1 Aligning KM with Business Strategy

when making future decisions. Because supply chain strategies can be driven by the collective intelligence and

competence to meet today's business challenges that enable organizational learning. Based on the above discussion, a successful knowledge-oriented business for organizations should link supply chain management, relationship management, and knowledge management to function in an adaptive way and continue to thrive in the e-business era.

II. Portal of Storm: Knowledge Diffusion and Assimilation

Over the past few decades, organizations have constantly "reinvented" themselves through a series of business and technological innovations to fit into the global spectrum of business. An e-business supply chain knowledge management is a new business philosophy that drives enterprises to transform their business intelligence. Organizations are becoming knowledge intensive instead of capital intensive. This new business philosophy is an integral part of the knowledge economy for today's organizations to remain profitable, competitive, efficient, adaptive, and more intelligent.

The design of a KM portal needs to focus on the issues of data acquisition, information access/retrieval for knowledge utilization, communication, knowledge sharing, business process/information integration, document management, and most of all—collaboration. The focus on collaboration and collaborative support is perhaps one of the major distinguishing factors that differentiates knowledge support systems from other information systems. In business practices, collaborative problem solving, conversations, and teamwork generate a significant proportion of the knowledge assets that exist within a firm or entire supply chain. With network connectivity, the virtual teams can work collaboratively to share knowledge and best practices that enable supply chain "co-evolving." The enterprises will be able to better work together on a project across departmental and organizational barriers. Under this paradigm shift, intelligence and control are no longer concentrated in division offices. Empowered workers are actively engaged in their jobs, and they have the authority to form autonomous teams with self-defined roles and structures. The project members to form a "virtual team" can be from different divisions, departments, or even organizations. Those empowering workers will lead to radically different organizations that can cope with the ever-changing business environment. Interdependency between core knowledge workers will increase as the success of the enterprise becomes more dependent on how well they integrate their knowledge to produce innovative products and services [2]. This is the key issue of today's knowledge-enabled organization, and many of the concepts are brought into discussions of this paper. The objective is to develop a knowledge management framework that brings people, information technologies, business process, and organizational strategy together to better utilize knowledge in business practices in a supply chain scheme. KM portal systems should support people to access and learn from past

and present organizational business practices/strategies and to apply the lessons learned when making future decisions. The portal is also platform-independent that makes it possible to deliver business data and streamline business processes across heterogeneous business partners in the flash of a second. As mentioned before, the portal for knowledge management systems must to address the strategic visions of organization. There are several factors needed to consider in order to develop a successful KM system. The first is to recognize the organization's competence.

III. The Value Chain and Information Processing Network

Traditional managerial hierarchy is not addressed in the horizontal nature of collaborative or team-based communications, because of its vertical emphasis on communications and information systems. The shift from a division/functional organization to a matrix, and then to a network form arose from a desire to create organizations that utilize knowledge across processes and functions. Especially the rapid growth of the Internet brought about a reevaluation of the old supply chain philosophy and fostered the growth of new strategic alliance and business process integration across the border of organizations, thereby enabling organizations to more fully utilize the skills, knowledge, competences, and resources found in their supply chain network.

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. 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. 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].

The information processing view of an organization has been considered one of the most influential contributions to the contingency literature [6]. In this philosophy, information processing network provides the channels for exchange

and processing of information in a global system. The primary system objective of the information processing network is to provide a communication backbone for information exchange among its subsystem, the information processing nodes. The information-processing nodes within the network are responsible for receiving, using, selecting, producing, sending, and communicating (i.e. exchange information) with other information processing nodes (Figure 2). As a result, the lattice of channels between the various information-processing nodes forms a physical communication infrastructure called an information-processing network.

In value chain, 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 or information processing network that encompasses the modern business world, and participating organizations can readily extend their technologies and knowledge 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].

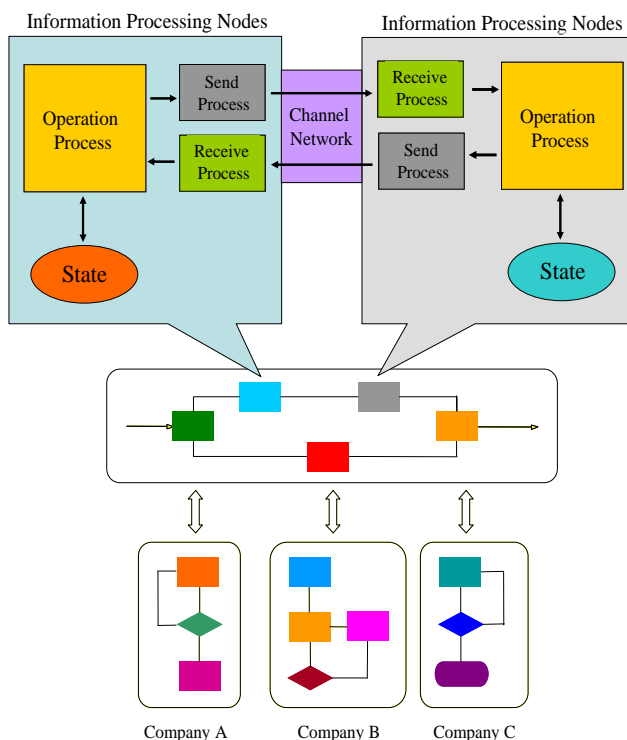


Figure 2 Information Processing View of Business Process Integration

This extended enterprise allows for the sophisticated interweaving of online business processes across trading partners and with other internal and external information sources. The usefulness of the integrated channels will be largely driven by new enterprise applications and KM portal that enhance the overall values. The following section will illustrate a typical integrated KM portal system for inter-

enterprise e-supply chain practices.

IV. The KM Portal System Architecture

The characteristics of information-processing nodes are much like the business components, but they conduct the actual exchange of information. The business components of the organization include people, processes, events, machines, and information that interact and combine to produce the products or output of the organization. People and information-processing machines, such as computers, are in this category. An enterprise operates as an information-processing system in a global information-processing network. Because it is an open structure, the network can be developed in a fractal pattern. The information-processing network can be expanded and connected to other organizations' information-processing networks. The information-processing nodes within each network in either organization can work collaboratively to achieve strategic goals in the newly joined network.

A typical enterprise KM portal is shown in Figure 3. In this figure, the KM portal act can like a groupware that supports not only several people working together on a task, but also their different and potentially changing roles. It has email and messaging functions, document management and information sharing, collaborative authoring, conferencing, time management, and some level of structured workflow support. Information can be managed only when it is embodied as content, which represents a specific combination of information and a manageable document [7]. Document management is a part of supporting IT, and it includes the ability to automatically develop and classify document databases.

Enterprise KM Portal		
Web Pages	To Do List /Calendar	Enterprise Applications
Conferencing/Chat /Discussion/E-mail	Search Tools and Directories	Document Management and Workflow
Project Management	Best Practices	Research
Database	Data Warehouse	News/Feedback

Figure 3 Typical KM Portal Components

In business practice, the project teams work collaboratively on the creation of documents and insuring that everyone has access to the latest updated version of the documents, which avoids working on the inconsistent versions of these documents. The KM portal is an integrated collaborative tool its database management ability organizes, stores, replicates, and provides shared access to documents by using a hypertext scheme. It has all the functionalities to

support basic business practices and knowledge management. The KM Portal system allows groups of users to interact and share information in an organized fashion and the documents can be posted on the Intranet or the Internet.

With the growing maturity of Internet technology, the KM portal can become more active. Applications can run on clients' browsers. The technological breakthrough makes the development of enterprise portal systems (utilizing corporate Intranet) easier in terms of communications and collab-

orations. The KM portal and Internet's hypertext scheme can easily profile different categories of business information for people working on the job site, or provide them with a "hyper-trail" for step-by-step operations. Behind the scene is a complex web that links different databases residing in the project team's organizations. With the aid of hypertext, an organization's information system becomes more accessible and adaptive, and the project data can be easily stored in archives for historical reference.

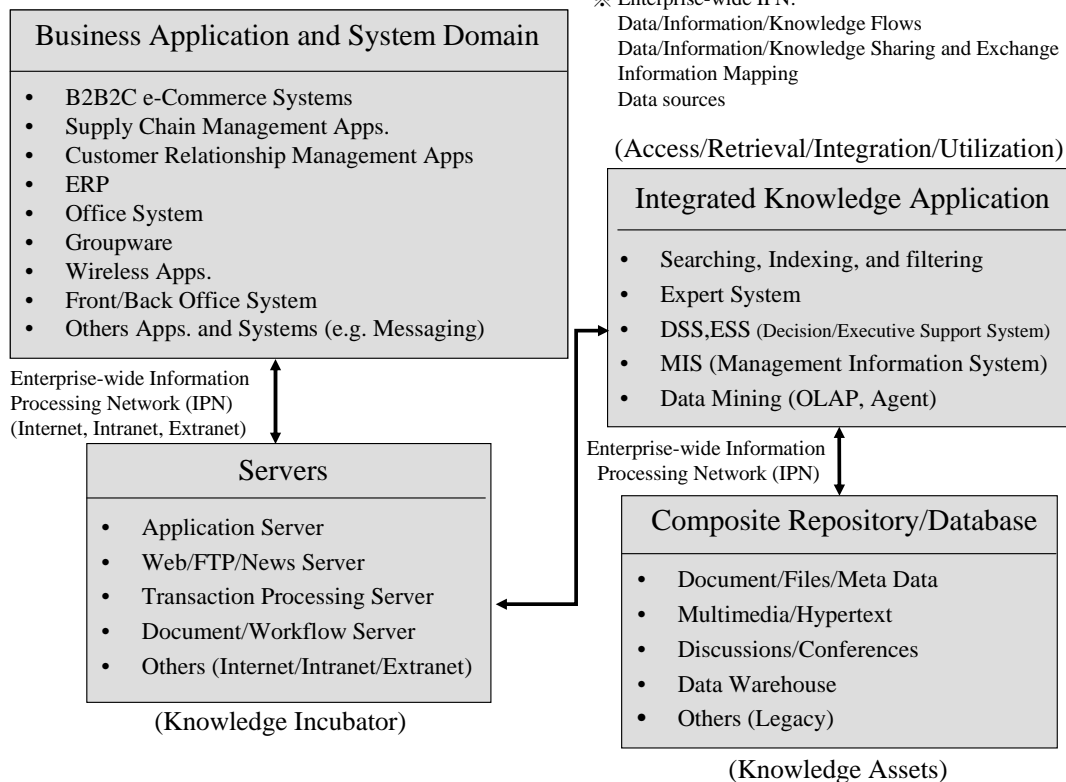


Figure 4 The KM Portal System Architecture

In this "knowledge portal" a dedicated knowledge server and database are required, because knowledge management must capture and retain in a central/distributed data repository the data and information that employees need. The technologies to facilitate these highly interactive communications are summarized in Figure 4. In this figure, for example, Internet/Intranet and groupware system are the most important ones for group communications and knowledge-sharing. For knowledge sharing, the architecture of IT in the knowledge management system is concerned with organizing and analyzing information in an organization's database so this knowledge can be readily available throughout a company. To help companies organize information residing in multiple locations and deliver it to prospective users, combinations of directory service, indexing, and searching are required in the KM system. Available groupware and document management systems do an excellent job in satisfying this requirement.

As mentioned, a central/distributed data repository that provides/captures the data and information for employees and executive decision-making is very important in a knowledge management system. The database is the core of a KM system, the decision-making support system is the driver that consolidates and directs the overall resources of the supply chain to the most mission-critical business activities to generate profits. It is believed that the next generation of knowledge management systems will be built on the Internet backbone with "agents" that flow through the net to gather business information and display it for decision-making purposes. On the other hand, the basic business applications are necessary to conduct daily business, such as word-processing, spreadsheets, accounting, and so forth. With the growth of the Internet, e-business is rapidly expanding into a complex web of commercial activities. Many organizations have recognized this competitive advantage and have shifted their focuses from process

improvement within an organization to process integration across their trading partners. This business-to-business practice transforms the traditional supply chain into a network that allows companies to work together and share knowledge. The key issue is the inter-enterprise processing. Therefore, this is the reason why knowledge management should include business processes integration.

V. The Learning Organization and Supply Chain Co-Evolving

In business practices, information is the glue that unifies businesses partnerships. Many organizations use their information processing networks and strive to become knowledge-enabled organizations to ensure that all employees are able to locate, access, and utilize the knowledge and skills they need to meet their individual and corporate goals. Senge in his thoughtful and provocative book [8] on system thinking described a "Learning Organization" as "an organization that is continually expanding its capacity to create its future." A knowledge-enabled organization is a learning organization, one where all employees are using their knowledge, skills, and learning to meet today's business challenges and to create new opportunities for the future. One thing important is that the organization also learns from customers, suppliers, and even competitors: from any and every relevant source within or outside the organization. An organization's value chain consists of all activities performed to design, produce, market, deliver, and support its product and service. Knowledge Management is introduced to enhance collaboration encourage innovation, boost productivity, achieve adaptivity, and increase the information system efficiency. The next generation of e-business will be built on an interconnected network which will help companies connect disparate systems, provide greater access to information, and more closely link employees and customers.

A successful knowledge portal and knowledge management system for today's new business must provide support for the capture and communication of users' demands, as well as enable these demands to automatically trigger business events and initiate process workflows. Indeed, a knowledge portal 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. Data is the basic building block of information and ultimately of a knowledge-based business. A common data model is needed for the entire supply chain knowledge network, because the effectiveness of an e-business supply chain solution will depend largely on its ability to deliver an accurate and common view of customer demand data, as well as any subsequent events, plans, or other business data. Therefore, the enterprises are capable of quickly consolidating critical competencies and physical processes to gain competitive advantages easily.

VI. Conclusion

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. The beauty of a supply chain knowledge network is that the true value of the information surpasses the conventional boundaries that often restrict employees' thinking [9]. The collaboration of people, processes, and technology is important, because companies can enhance customer satisfaction, improve operational efficiencies, and cut costs by leveraging a comprehensive, integrated, e-business suite of applications based on Internet technology. Information can be managed only when it is embodied as content, which represents a specific combination of information and a manageable document. A KM infrastructure combines automation, business rules, artificial intelligence, workflow, analytical tools and advanced messaging-analysis technologies to allow e-businesses to deliver information and to respond to customer requests rapidly and accurately [10]. In a successful "k-business" model, the sharing of information moves the supply chain closer to the desired goal of a demand chain. In this way, a true knowledge management system can be built and utilized by the entire supply chain community to generate profits. 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. Enterprises will need to learn that content communication is as important as technological infrastructure to the enterprise software application architecture. This new "e-supply chain" offers unlimited business opportunities when enterprises fully integrated their knowledge, processes, and technology. A well-designed and well-integrated knowledge portal will improve existing supply chain performance and provide organizational agility in the event of change.

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Total Quality Management (Tqm) Model for Knowledge Management Systems (Kms) in Thai Communities

Poonsook Janpen *, Prasong Praneetpolgrang **, Pong Horadal+

* Project Office for Consortium on

Doctor of Philosophy Programs Pranakhon Rajabhat, University

3 Moo 6 Jangwattta Rd, Bangkhen, Bangkok, 10220 Thailand

poonjan79@hotmail.com

** Master of Science (Information technology) Graduate School,

Sripatum University

61 Phaholyothin Rd, Jatujak Bangkok, 10900 Thailand

prasong@spu.ac.th

+ Project Office for Consortium on

Doctor of Philosophy Programs Pranakhon Rajabhat, University

3 Moo 6 Jangwattta Rd, Bangkhen, Bangkok, 10220 Thailand

Abstract: Knowledge management systems (KMS) are commonly tacit patterns practiced in Thai communities. Effective KMS is essential to successfully implement knowledge management (KM) and sustainable development organization. Appropriate model of total quality management (TQM) for Thai community's knowledge management systems will be designed. This study incorporated the concepts and theories of TQM models, KM and KMS in Thai communities. Index and standard of knowledge quality are analyzed and integrated concept of analytical TQM and Delphi technique are applied.

Keywords: Total Quality Management (TQM), Knowledge Management (KM), Community Development.

I. Introduction

The ability to manage quality of knowledge is becoming an essential core process sustainable development of today's organizations. Knowledge management (KM) theories and approaches have been adopted that they are the processes and strategies for continuing improvement [1], [2]. Knowledge management is large and complex issue includes management and operational practices and philosophies, technologies, strategies and human behavioral traits. Though they are different ways in working and results of KM implementations [3].

Creation, transferable, usability, storing and reusability of the knowledge are the most important notion of knowledge activities in knowledge management systems (KMS). An organization's KMS to provide competitive advantage needs both cognitive and social components, interconnected with individual member's cognition and social practices. The structural index which identify knowledge agents, evaluate knowledge sharing among organization members, and objectively assesses the contribution of knowledge agents are the benefits of KMS application [4].

Total Quality Management (TQM) is a mindset and a set of continuous and keeps on improvement processes for individuals, groups and whole organizations by understanding and discovering better process. Its major techniques provide a set of general governing principles; delight the customer, people – base management, continuous improvement, and managements by fact. And produces the excellence achieving results that delight all the organization's stakeholders (this includes employees, customer, suppliers, society in general and those with financial interests in the organization) [5].

Both KM and TQM are improving processes of the organizational qualities. The similarities of them include: result orientation, people base management, teamwork, leadership and delighting the customer. The differences are distinctive focus; approach of TQM is improvement base on fact, while KM is base on building a culture to support knowledge creation and sharing. Practical philosophy of TQM is "understanding and discovering" better process, while KM is "invented or identified" what people were doing and try to doing best practice and radical reinvention[5][6]. Though complement TQM with KM is possible and with properly TQM model planned KM process will be more effective and efficiencies.

Quality of life and sustainable of communities development, administrators as well as population will know what are the core value, core competency, and core knowledge of their living style and environment. They will know what critical knowledge of community is lacking or losing, and what are essential. These want suitable KMS, is powerful tool and important strategy KM implementation. This study is based on these concept (1) belief in community potential, (2) the TQM and KM theory which posits that tacit KMS has been in each communities, (3) concept of TQM can applied in public service organizations and (4) KM is effective in developing communities. Using TQM analytical techniques, knowledge of Thai community are identified and knowledge quality index and standard are established. By identifying the steps in famous TQM models, TQM model for KMS in Thai communities are designed. The model are tested and developed by integrated TQM and Delphi

technique. The model will serve as a theoretical framework and pragmatic foundations for identifying and categorizing knowledge qualities, management and measurement of community's knowledge assets; this assured the effective of KM activities and KM feedback.

II. Literature Review

II.1 KM and KMS

Although knowledge and knowledge management concept is practice as early as 4000 years ago. Knowledge management systems (KMS), which involve the application of IT systems and other organizational resources to manage knowledge strategically, are a relatively recent phenomenon. It is generally accepted that knowledge come from individual learning experiences and also comes from the meaningful organized accumulation of information through experience, communication, or inference. The adequate knowledge management processes is considered of a key factor for improving the organization's performance and long-term survival.

Definition of knowledge management means different in understanding of the term knowledge. In the past KM has been focus on information technology and information systems, but the new focus is on knowledge as distinct from the data-centric and information-centric. In perspective of process, the four basic activities: creating, storing, transferring, and applying are regarded, a complex mix of business processes, people, and technology is KM successful [7], [8], [9].

Adoption and diffusion of KMS are studied in the context of some Australian organizations factors and variables are identify, and they are found four major variables affecting KMS diffusion as: organizational culture, top management support, benefits to individuals, and dream of KMS [10].

In KMS 'Knowledge Management Gaps' that might occur when implementing the KM system. The reasons for these gaps and several fundamental approaches for avoiding them are the mismatch between the capability and greatly enhance the effectiveness of implementation of the KM system [11].

The KM development surveys using a literature review and classification of articles from 1995 to 2002 with keyword index in order to explore how KM technologies and applications have developed in this period. KM technologies using the seven categories as: KM framework, knowledge-based systems, data mining, information and communication technology, artificial intelligence/expert systems, database technology, and modeling, together with their applications for different research and problem domains. Some discussion is presented, indicating future development for knowledge management technologies and applications as the followings: (1) KM technologies tend to develop towards expert orientation and KM applications development is a problem-oriented domain. (2) Different social studies methodologies, such as statistical method, are

suggested to implement in KM as another kind of technology. (3) Integration of qualitative and quantitative methods and integration of KM technologies studies may broaden our horizon on this subject. (4) The ability to continually change and obtain new understanding is the power of KM technologies and will be the application of future works.

II.2 Quality and TQM

The success of quality management is base on several quality models. Much of perspective and popular literature on TQM subscribes that TQM is "universal" in its application ability. This appears on many levels the institutional, national and certification schemes.(e.g. European Quality Award, the Malcolm Baldrige National Quality award, QS 9000, IS 9000). The proposed TQM model can serve as a prototype for implementing quality improvement programs in manufacturing and service-sector settings.

II.3 TQM and KM

Research on Total Quality Management (TQM) and Just-in-Time (JIT) find that there is evidence supporting the compatibility of the practices in these programs and that manufacturing performance is associated with the level of implementation of both socially- and technically-oriented practices of the three programs.

TQM is an organizational culture dedicated to training, continuous improvement, and customer satisfaction. Empirical studies which have examined the relationship between TQM and organizational performance have investigated the impact of each dimension of TQM on performance separately. These studies have indicated that only a handful of the soft aspects of TQM (i.e., 'human factors' like commitment, team work and so on) contribute to organizational performance. Our contention is that soft TQM actually plays a number of roles. One is to create an environment where seamless dimension and implementation of hard TQM can take place, and the other is to directly aspect organizations' performance in the same way that traditional human resource management (HRM) practices can impact on an organization. The previous attempts to identify the relationships between elements of TQM are suggested. The first approach conceptualizes TQM as a limited set of technical tools (such as statistical process control and Pareto analysis) while the second approach views TQM as part of broader changes to human resource (HR) practices. Through examining computer, automotive, health care and banking industries in four countries, they found that the use of hard TQM tools tends to be more profound in companies that adopt strategies to increase stakeholder commitment and incorporate

III. Research Methodology

In this study, survey and analysis and Delphi Technique are integrated. Research processes are designed as following:

1) Documentary investigates on philosophical definitions, concepts, theories, and some examples of successful implementation on quality, TQM models, information standard, and measurement of knowledge assess, KM, and KMS.

2) Local Thai communities' structure, ways of public solving concept, wisdom and communities' life are analyzing for finding Thai communities' KMS framework. Survey and analysis Techniques are used.

3) In order to Thai communities' culture and environment, knowledge quality index and standard are settled. And the model of TQM for Thai community's knowledge management systems is designed and proved by Delphi Technique.

The model of TQM for Thai community's knowledge management systems is improved and then presented to public.

IV. Preliminary Results

Documentary investigation confirms possibility and usability of TQM application for Thai community' KMS. Preliminary results show that:

- 1) Knowledge is very important factor of community's potential growth. Each community has their KMS, which are different by community's way of life and environmental context.
- 2) Important factors of successfully organization in KM implement are knowledge sharing and innovative by nature of cultural organization.
- 3) There are a lot of tacit and explicit knowledge in Thai's communities, in difference forms such as tales, folk songs, literatures, way of lives, traditional curatives, home decoration style, and belief in religions ect. Most of them are not investigate in scientific methods. According to lack of dissemination systems mapping and suitable analytical tools, those knowledge are only garbage data and information.
- 4) TQM is philosophical and processes of organization quality investigation and improvement of inputs, processes and outputs. TQM techniques are assembly line, design of products for manufacture, and the end-to-end optimization of entire process. The improvement processes depended on collecting data and information, and analyzing, sharing codifying knowledge and discoveries. Usefully implementation technique will be suitable designed for organization circumstances, and successfully depended on having the knowledge people about individual parts of process work together in teams and share their knowledge that could be best decision made. So TQM could be integrated with KM and organized KMS communities effective able.

KM is the organizational behavior, knowledge sharing culture, and knowledge solution habit. Integrated Thai

communities' KMS with TQM model is needed to improve knowledge sharing, creating, and solving processes in society's value.

V. Conclusion

This study relation between KM, TQM model and quality definition are analyzed. The results confirm the importance and possibility of quality knowledge improvement in Thai communities by applying TQM to KMS. These results also confirm the relevance behind the management of both the technical and human aspects in knowledge quality processes, and potential of TQM and KM to generate competitive advantages. Thus, communities' knowledge index and standards will be designed and TQM model for Thai communities will be developed.

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The Adoption of Mobile Short Message Services: Implications for Managing Value-Added Services in the Telecommunications Industry

Ziqi Liao

Department of Finance and Decision Sciences

Hong Kong Baptist University

Kowloon, Hong Kong

Telephone: (852) 34115227 e-mail: victor@hkbu.edu.hk

Abstract: This paper empirically explores several variables associated with the adoption of mobile short message services (SMS) from the consumer perspective. The results suggest that perceived usefulness, ease of use, behavioral control and reliability significantly explain the consumers' behavioral intention to use the mobile message services. The findings have practical implications for managing the value-added services in the telecommunications industry.

Keywords: Mobile commerce and business, value-added services, consumer behavior

I. Introduction

Emerging mobile commerce has great potentials because of its mobility and flexibility. It operates in the environment that is different from e-commerce conducted over the wired Internet. As one of the value-added services, the wireless SMS is increasingly popular. A key issue for the service providers is to appreciate the major factors of the SMS and consumer behavior in order to achieve the expected value of the services.

Existing studies in relation to the acceptance of information technology tend to explore attitudes, beliefs, and behavioral intentions of users. For instance, the technology acceptance model (TAM) was used to explore the acceptance and adoption of computer-based information systems [5]. Numerous studies were conducted to assess, validate and extend the TAM [1] [13] [16] [18] [19] [21] [22]. In addition, the theory of planned behavior (TPB) was emerged as one of the dominant social cognitive frameworks for understanding exercise motivation and behavior [2]. The TPB provides a parsimonious explanation of informational and motivational influences on behavior. The TPB could be considered as a deliberative processing model, which might be used to account for situations when performing a behavior was not entirely under the volitional control of the actor [2] [3]. Furthermore, Taylor and Todd [18] present the decomposed theory planned behavior (DTPB), in which attitude, subjective norm and perceived behavioral control contribute to behavioral intention. Further, they demonstrate that both TPB and DTPB can explain behavioral intention.

As a technology-based service, the adoption of the mobile SMS might be influenced by a number of demand-

side variables. Therefore, this paper aims to explore the use of wireless SMS from the consumer perspective. It begins with the description of several hypotheses followed by research methods. On the basis of the regression results, it discusses the key variables together with their impacts on consumers' intention to use the wireless SMS. Finally, the paper is concluded by highlighting the implications for managing value-added services in the telecommunications industry.

II. Hypotheses

Firstly, perceived usefulness affects individual attitude and intention to use a computer-based information system, which ultimately determines actual usage behavior [5]. It has been found that the acceptance of information systems is driven to a large extent by perceived usefulness [1] [7]. Other studies also show that perceived usefulness is positively associated with system usage [11] [12] [20]. It seems meaningful to test this argument in the case of the SMS. Therefore, H1 is proposed.

H1: Perceived usefulness positively influences consumers' intention to use the SMS.

Secondly, perceived ease of use could be a potential catalyst to increasing the likelihood of user acceptance [5] [7]. Perceived ease of use should be a quality attribute in IT-based services [4]. Perceived usability depends on ease of use [9]. This can be explained as stemming from a situation where the easier a technology is to use, the more useful it can be. As a matter of fact, perceived ease of use can directly contribute towards behavior [16]. In the case of the SMS, the message is entered through several keys and appears on a small display of a cell phone. It would be desirable if the operations were simple and user friendly. Therefore, H2 is proposed.

H2: Perceived ease of use positively influences consumers' intention to use the SMS.

Thirdly, social influence possibly affects the acceptance of a technology [8]. It may play a role in determining how users make their decisions about adopting and using a new technology [23]. According to [2], subjective norm reflects the degree to which referent others want the individuals to perform a particular behavior. The relative influence of subjective norm on intention is expected to be stronger for potential users, since they are likely to rely on the reactions

of others in forming their intentions [10]. In the technology domain, both peer and superior influences have been shown to be strong determinants of subjective norm [16] [19]. In order to test the impact of subjective norm on the SMS, H3 is proposed as follows.

H3: Subjective norm positively influences consumers' intention to use the SMS.

Moreover, the TPB incorporates a construct, namely perceived behavioral control, to account for a situation in which an individual lacks substantial control over the targeted behavior [2]. Perceived behavioral control refers to an individual's perception of the availability of requisite resources or opportunities that are necessary for performing a behavior. It can capture the perception about the skill and knowledge required to engage in a particular activity [2] [3]. It can also be measured by asking individuals about the potential barriers and costs of using a technology [14]. According to the TPB, perceived behavioral control has a direct effect on behavioral intention. Hence, H4 is proposed.

H4: Perceived behavioral control positively influences consumers' intention to use the SMS.

Lastly, perceived reliability is fundamental to product and service quality. In the case of service operations, reliability refers to the ability to dependably and accurately perform a service [15] [17]. The mobile SMS involves such risks as privacy and security, which may affect consumer behavior and dependability of the service. Therefore, H5 is proposed.

H5: Perceived reliability positively influences consumers' intention to use the SMS.

III. Research Methods

The research methods include survey and data analysis. Firstly, a questionnaire was designed to elucidate consumer feedback on the SMS. It consisted of a number of questions in relation to perceived usefulness, ease of use, subjective norm, behavioral control and reliability. The respondents were requested to provide their observations based on seven-point Likert-type scale ranging from 1 to 7. As a result, one hundred ninety five responses were received from mobile users at this stage. Based on the data collected, several procedures associated with the Statistical Package for Social Science were used to test the above hypotheses.

IV. Results and Discussion

The impacts of several attributes on consumer behavioral intention are examined using multiple regression analysis. In the present regression model, consumer behavioral intention is endogenous variable, while perceived ease of use, perceived usefulness, subjective norm, perceived behavioral control and perceived reliability are exogenous variables. Table 1 displays the regression results based on the data

randomly collected from different mobile users. The regression analysis suggests that perceived ease of use, usefulness, behavioral control and reliability significantly influence consumers' behavioral intention ($F = 43.309$, Sig. < 0.001). In addition, the value of adjusted R^2 indicates that the exogenous variables collectively explain 52.7% of the variance of consumers' behavioral intention to use the wireless SMS. Therefore, H1, H2, H4 and H5 are supported.

In general, service providers can strengthen the relationships with customers through encouraging the use of a particular service. If the individuals start to use a value-added mobile service, they might gradually appreciate the usefulness and tend to use the service in a more frequent manner. In other words, the impact of perceived usefulness on behavioral intention to use may increase over time. In addition, perceived ease of use considerably affects consumers' behavioral intention. It remains a primary concern in the case of the mobile SMS, which is similar to the case of the implementation of information systems. Therefore, the mobile service providers should improve the interface of the wireless SMS and enable more user-friendly operations.

However, the results indicate that subjective norm does not significantly affect behavioral intention. Hence, H3 is not supported. The link between subjective norm and behavioral intention may due to perceptions of the real consequences associated with use [18] [19]. It seems that the behavior of the other people has little impact in the case of mobile SMS. The mobile users are likely to have independent assessments and simply use the service from time to time.

Table 1 Results of Regression Analysis

	β	t	Sig.
(Constant)		3.956	.000
Usefulness	.201	3.242	.001
Ease of use	.319	5.054	.000
Subjective norm	-.012	-.217	.828
Behavioral control	.148	2.104	.037
Reliability	.298	4.819	.000

Note: Adjusted $R^2 = 0.527$

Furthermore, perceived behavioral control has a significant direct effect on behavioral intention. This is consistent with findings of prior studies [16] [18]. In this case, the consumers tend to use the SMS, if the service charge is very marginal in addition to the existing mobile service. This suggests that in order to encourage more consumers to use the SMS, the service providers should consistently reduce the cost of the service.

Finally, perceived reliability has a significant effect on behavioral intention. Consumers are concerned about the uncertainty and privacy when sending personal messages. Though the wireless SMS is useful for facilitating individual communications, individuals would not usually use the SMS to deliver sensitive personal data. However, the SMS has been widely used for promoting and advertising products

and services. It is not uncommon that the SMS has been abused to disseminate information for unacceptable commercial activities. Some may be frustrated by the receipt of many commercial messages. Therefore, the commercial SMS must be governed in order to enhance the confidence of the consumers in the mobile service providers.

V. Conclusion and Implications

This study examines the major considerations in relation to the use of wireless SMS. The results suggest that perceived usefulness, ease of use, behavioral control and reliability have substantial effects on behavioral intention to use the SMS. In general, consumers have appreciated the usefulness of the SMS. They are able to use the service because it requires limited expenses. More importantly, the mobile services providers should devote to develop more easy to use interface and user-friendly programs for the SMS. Moreover, they should further enhance the reliability of wireless communications. Even if individual demands and expectations may vary in different environments, the service providers must pay attention to the changing needs of the customers and continuously improve their existing wireless service operations and competitive strategies.

The findings of the study have practical implications for developing and managing different value-added services in the telecommunications industry. At present, the SMS is relatively popular to mobile users. However, other wireless applications such as mobile shopping and mobile banking are yet to be further developed, although the services are recently available. Moreover, there are various innovative value-added mobile services being developed by different service providers at present. Some applications are still at the early stage of development and relatively new to consumers. It is not uncommon that individual consumers may not be able to evaluate the usefulness of an innovative value-added service prior to implementation. The difficulty in measurement might be attributed to the fact that perceived usefulness is a measure that takes time to assess. It is also difficult for the service providers to quantify the value of a new value-added service before it has been extensively used by different customers. Therefore, the service providers in the telecommunications industry are suggested to consistently explore the determinants of an innovative value-added service in a particular social context in order to formulate appropriate business strategy for the service and realize the expected business value of the service.

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Isomorphism and Mobile Commerce Strategy

Wenshin Chen

College of Business

Prairie View A&M University Prairie View, TX, USA

wechen@pvamu.edu

Abstract: Experts continuously predict that mobile technology would create new competitions in the business world and that all e-commerce would be on wireless devices in the near future. This technological trend indicates that M-commerce has been envisioned to be a major force of business competition. To any organizational member in an institutional field, a more comprehensive understanding of M-commerce strategy would thus become critical. Since conventional wisdom emphasizes economic aspects of technological strategy, a more comprehensive understanding of M-commerce would need to incorporate social/political aspects of strategic choice because such social/political backdrops in an institutional field often shape an organization's decision. Institutional theorists, for instance, argue that organization members' decisions are often driven by social/political pressures in an institutional field, particularly when the environment is surrounded by emerging technological issues. With its developing nature, M-commerce well fits into such an uncertain context. Institutional theory could thus help better understand how social/political forces in an institutional field influence an institutional member's decision. More specifically, this paper proposes that each of three isomorphic pressures, coercive, mimetic, and normative pressures, positively influences an organization's M-commerce strategy. These propositions encourage business and technology decision makers to consider social/political factors embedded in their institutional landscape and in turn better shape their organizations' M-commerce strategy.

Keywords: Mobile Commerce and Business, Isomorphism, Institutional Pressure

I. Introduction

As the Internet technology and the electronic market mature, emerging business competition beyond E-commerce has become increasingly significant in the business world [23]. Mobile commerce (M-commerce) has been predicted to become such a force to create new challenges and opportunities beyond the E-commerce market [13]. While the potentials of M-commerce have been extensively discussed by practitioners (e.g. [25] [46-47]), empirical studies that help understand and manage M-commerce strategy have not been parallel. The inadequate empirical studies of M-commerce might be due to the rapidly evolving

nature of mobile technology. However, as M-commerce creates a new competitive market and potentially transforms the manner in which business is conducted [12] [35], an insufficient understanding of such an emerging phenomenon might cause organizational inability to make an effective strategic choice. The purpose of this paper, thus, seeks to shorten the gap between practitioner's discussion and empirical research. It intends to examine an organization's strategic choice of M-commerce in an institutional field and in turn helps decision makers to better shape their M-commerce strategies.

Specific research questions of the study are mainly derived from the evolving nature and uncertainty of mobile technology. Research community has increasingly called for attention to issues and challenges of mobile technology [15] [19] [40] [44]. These technical challenges and standard issues of mobile technology prohibit an organization from fully envisioning the future of technological evolution. The rapid development of mobile technology could also exceed organizations' implementation capacity—before organizations fully comprehend the current technological capability, new devices or services might have appeared in the market. As such, high degree of technological uncertainty and complexity is involved in an organization's strategic choice of M-commerce, particularly in an institutional field where business competition is intense and social and political landscape is complicated. The paper thus asks: why does an organization adopt M-commerce strategy under such high uncertainty? What would an organization gain from the adoption of M-commerce strategy?

While conventional information technology (IT) strategy literature widely emphasizes economic aspect of strategic choice [26-27], the paper, in contrast, focuses on social and political aspects of strategic choice of IT in general and mobile commerce in particular. Derived from institutional theory, it specifically seeks to shed light on how isomorphic pressures influence an organization's adoption decision of M-commerce strategy. In the context of M-commerce, the discussion of isomorphic pressures could help better understand how an organization's decision making is driven by social and political landscape in an institutional field. The knowledge gained could thus encourage business and technology decision makers to consider not only economic but also social and political issues of M-commerce adoption and in turn better develop their M-commerce strategies.

I.1 The Potential of M-commerce

This paper draws the definition of M-commerce from Tarasewich et al—"all activities related to a (potential)

commercial transaction conducted through communications networks that interface with wireless (or mobile) devices” [40, p. 42]. The reason of employing this definition is that it is one of better examples that specify the mechanism through which M-commerce is conducted. Such mechanisms—mobile devices—could include mobile phone, handheld computers, laptop computers, personal message pagers etc.

Practitioners have predicted that M-commerce could potentially turn a mobile phone into a retail outlet in a customer’s pocket [38] and change how firms sell and provide services for their customers [30]. It could also explosively influence particular industries such as financial services, travel, and retail businesses [35] and even more significantly, change firms’ business model [39] and IT strategy [31] [34]. Amazon.com founder Jeff Bezos even predicted that within ten years all e-commerce activities would be conducted through mobile devices [39]. In line with this view, Forrest Research reported that 90% of European companies intended to develop mobile Internet sites and 50% of them have already launched their development in the beginning of 2000s [8]. By the end of 2005, the US market will have more than 171.1 million mobile Internet users and 111 million consumers will access mobile Web on a monthly basis [12]. A survey in the US further indicated that mobile phones will become the second highest potential reach as an advertising medium only next to television [47]. The revenue that M-commerce will generate by the end of 2005 is predicted to be more than 100 billion worldwide [39].

However, all these predictions are mainly drawn from economic perspectives. If an organization’s decision making were simply based on such perspectives, the organization would then fail to understand social and political factors that play a significant role in influencing the success of technological adoption [1] [22]. With respect to an organization’s decision making, economic perspectives are derived from organizational voluntarism, which assumes that an organization’s strategic choice is simply a voluntary action so that it could be decided via an organization’s internal need assessment. Such a perspective neglects external factors such as environmental competition or institutional pressures. Zmud’s [48] push-pull model suggests that factors leading to an innovative action could be mainly categorized into push and pull forces. Pull forces stem from an organization’s internal evaluation of performance gaps or operations needs [7]. Push forces, on the other hand, result from a variety of external factors such as a promising technology, norms of the social systems [32], competitive pressures [21] or institutional influences [1]. In other words, an organization’s initiation of an innovation often results from both internal and external forces.

Institutional theorists further illustrate that one of external forces—institutional pressure—often leads to an organization’s isomorphic changes in a collective field. The organization tends to act in a similar fashion because of isomorphic pressures they face instead of their need to

obtain efficiency [9]. Such an institutional perspective provides social and political explanation of an organization’s behavior, extends traditional economic perspective, and in turn helps gain a more comprehensive understanding of strategic choice of M-commerce.

II. Institutional Theory

Institutional theorists argue that organizations act, not to increase cost efficiency, but to gain legitimacy [5] [18] [37]. Much of the ideas, values, and beliefs that an organization acts upon are influenced by institutional members instead of the organization’s needs of economic efficiency [28]. To survive, organizations have to first obtain institutional recognition; acting to accommodate institutional expectations, regardless of efficiency or cost benefits, would help to gain institutional recognition and in turn enhance survival opportunity [9].

Traditional wisdom of organizational voluntarism assumes that organizations make decisions based on their rational calculation of performance needs. In reality, however, institutional members would often follow the trend of institutional fashion and act collectively with other institutional members. An organization’s action in this pattern does not necessarily gain profit or efficiency. Instead, the result often lies in social recognition or political support [20]. Hiring a Nobel Prize winner, for example, would not be financially justified for a university; it could nonetheless attract better students or research opportunities and in turn gain better recognition for the university [9]. Such institutional actions have become common practice in the academia so that any university would highly sanction the legitimacy of actions. As a university acts toward the direction that is highly sanctioned, other universities would feel the urge or pressure to act in a similar fashion to gain institutional recognition. A university’s action thus does not necessarily result from internal, rational calculation of performance needs. Rather, it is highly influenced by institutional pressures resulting from common practice or collective action in the field. Such institutional pressures emerge to be powerful forces that cause institutional members act in an isomorphic pattern as illustrated by DiMaggio and Powell:

Once disparate organizations in the same line of business are structured into an actual field (as we shall argue, by competition, the state, or the professions), powerful forces emerge that lead them to become more similar to one another [9, p. 148].

These powerful institutional pressures could be due to institutional members’ dominant movement or governmental regulations. In relation to technological investments, an organization does not necessarily rationally evaluate its return of investment for the innovation. Instead, the motive for an organization to adopt an innovation often stems from standardized practices in the field [24] seeking for normative recognition [45], as illustrated by DiMaggio and Powell:

As an innovation spreads, a threshold is reached beyond which adoption provides legitimacy rather than improves performance... Strategies that are rationale for individual organizations may not be rational if adopted by larger numbers. Yet the very fact that they are normatively sanctioned increases the likelihood of their adoption [9, p.148].

In other words, an organization's technological adoption is often a function of institutional pressures—the fear of being different from other institutional members [2]. So long as an organization resides and competes in the field, it could not escape from these pressures. An organization's action, therefore, is often undertaken for considering other institutional members' action and result in a collective, isomorphic pattern [9], which seeks for social and political recognition and sequentially survival chances [28].

II. 1 Isomorphic Pressures

According to DiMaggio and Powell, the organization's collective action is mostly driven by isomorphism embedded in an institutional field. They specify isomorphism as “a constraining process that forces one unit in a population to resemble other units that face the same set of environmental conditions” [9, p.149]. These institutional theorists further contend that three sources that lead to isomorphism are coercive, mimetic, and normative pressures.

II. 2 Coercive Pressures

Coercive pressure is generally caused by governments or other powerful organizations in the same field. When governmental agencies enact industrial rules [22] or when powerful industrial leaders impose standardized practices [14], other organizations in the field would perceive an urgent pressure. This type of pressure rises from facing ‘must-have’ institutionalized rules or practices. Failing to cope with this type of institutionalized rules or practices could result in fatal failure. Adopting a new pollution control or prevention technology in certain fields where environmental issues are sensitive is one example that organizations respond to such coercive pressure [e.g., 36].

Since M-commerce has been predicted to be one of the most influential emerging technologies in changing a firm's competitive strategy [13] [31], a firm situated in a competitive institutional field will inevitably face strategic choices of M-commerce. Nowadays, a firm cannot compete against others if it does not well develop an E-commerce strategy. With increasing influences predicted by practitioners, M-commerce, similar to E-commerce, would soon become a “must-have” IT strategy; a firm without M-commerce strategy would then face difficulty in the competitive market in the near future. Failing to employ a clear M-commerce strategy, a firm could be excluded in the competitive market. In other words, a firm without M-commerce strategy would perceive high degree of coercive pressure. Such pressure would urge it to rapidly make strategic choice of M-commerce to compete at the same

level as other firms in the industry. As such,

P1: the greater the coercive pressures, the more likely a firm will adopt M-commerce strategy.

Two specific sources of coercive pressures could influence a firm's adoption of M-commerce strategy. First, the standard of mobile technology has not been well reconciled, especially in the US market [10] [34] [46]. This situation would encourage technologically leading firms quickly step in and standardize the practices for M-commerce. The more such leading firms are perceived as powerful and influential in the industry, the more likely other firms would be subjected to emerging mobile technological standard and subsequent coercive pressures. As such,

P1a: the greater power and influence of leading competitors, the more likely a firm will adopt M-commerce strategy.

Second, governmental agencies could also involve in the standardization of mobile technology. They could create a universal standard of mobile technology for the nation so that the technological compatibility across various vendors and devices could be achieved. Governmental intervention usually imposes coercive pressure directly on a firm so that certain standardized rules and practice have to be complied [22] [24]. With respect to mobile technology, such governmental intervention would also enable the compatibility of various standards. As such, it would, on the one hand, create coercive pressures on technologically leading firms and demand their compliance on the technological standards and, on the other hand, achieve higher technological compatibility, which would in turn ease the implementation and facilitate the adoption of M-commerce for other firms. Both situations would lead to more prevailing acceptance of M-commerce in the field. As such,

P1b: the greater the involvement of governmental agencies in the standardization of mobile technology, the more likely a firm will adopt M-commerce strategy.

II. 3 Mimetic Pressures

Mimetic pressure, in contrast, is primarily related to the uncertainty of environment and technology and the ambiguity of an organization's strategy. When the environment or technology is uncertain and an organization's strategy is ambiguous, an easier way for an organization to establish itself is to model after those who have been widely recognized in the industry [9] [24]. Following others' footsteps could minimize the risk due to high degree of environmental uncertainty or high cost of technological investment. For firms that are not widely sanctioned, the imitation of legitimate competitors becomes a voluntary but critical behavior to respond to the fear of being different [1] and help establish a firm's legitimacy [45]. Evidences have shown that in the context of EDI (electronic

data interchange) mimetic pressures perceived by an organization positively influence its adoption of the EDI systems [41]. In the context of M-commerce, issues involved in technological standard and infrastructure create both environmental and technological uncertainty [19] [40]. On the one hand, M-commerce is perceived as a significant strategic factor [34] so organizations inevitably perceive institutional pressures to adopt it. On the other hand, consumers remain unwilling to embrace M-commerce activities [25] because of the still uncertain stage of the technological development [34], the complicated mobile payment structure, and slowly developing wireless-telecommunication industry [46]. An organization might thus perceive that the investment could be costly and benefits might not be rewarding [25] [46]. Such context would then create mimetic pressures that encourage a firm to benchmark legitimate competitors and consequently adopt M-commerce strategy.

P2: the greater the mimetic pressures, the more likely a firm will adopt M-commerce strategy.

According to DiMaggio and Powell [9], mimetic pressures are mainly derived from two factors—external and internal factors. Externally, the significance of institutional practices and high uncertainty of the environment or technology constitute two major factors of mimetic pressures. More specifically, the significance of institutional practices stem from the prevailing usage of technologies and the perceived success of adopting firms [41]. In other words, an organization's decision to adopt emerging technologies is driven by the extent to which the technology is used in the field and the perceived success of firms that have adopted it. Enabled by mobile and relevant technologies, M-commerce thus cannot possibly escape from these effects in the institutional field; neither could it avoid environmental and technological uncertainty accompanied by emerging mobile technologies due to their developing and uncertain technological standard and infrastructure. Such uncertainty and the significance of institutional practices would unsurprisingly encourage an organization to model itself after other firms that have been successfully implemented M-commerce strategy.

P2a: the greater the uncertainty of mobile technology, the more likely a firm will adopt M-commerce strategy through imitating successful firms.

Internally, an organization's perception of mimetic pressures would be strengthened when it lacks of a clear strategy. The pioneers or early adopters of emerging innovations in the industry usually have a clearer vision with respect to adopting certain institutional practices or technologies to meet their organizational needs [41]. Other firms without a clear strategy, in contrast, would fear to be behind or to be different [1]. Such fear would encourage them to follow common and successful practices in the field so that the risk of technological implementation could be reduced [9]. In the context of M-commerce, technological

uncertainty would further push those who do not have clear business or IT strategy to model after firms that have successfully implemented M-commerce strategy.

P2b: the greater the ambiguity of a firm's strategy, the more likely a firm will adopt M-commerce strategy through imitating successful firms.

II. 4 Normative Pressures

Normative pressure, finally, is derived from the professionalization, the process through which the information is exchanged informally among professionals or formally through professional networks and associations [24]. Organizations in a collective field that consists of considerable amount of professional workforce will struggle to maintain prestige and resources, which are two major elements to attract professionals [9]. The professionalization process will encourage isomorphic behavior among organizations because organizations are inevitably inclined to demonstrate their capability to provide at least the same, if not better, benefits and services as their competitors do. Highly professionalized organizations (e.g., those who provide better benefits and services to their employees) will be recognized as more competitive and prestigious [24]. They will be more capable of not just retaining their employees but also attracting better workforce from the market. Their competitors, therefore, will face the pressures to model the benefits and service provided by these leading professionalized firms. In so doing, they could illustrate the willingness to maintain their employees and the desire to be recognized in the field [16].

Computer industry, where IT professionals generally share information rapidly and tend to identify themselves with their professions (e.g., programmers, system analysts) instead of with the company they currently work for, is one typical context in which normative pressures would emerge. Such normative pressures are positively related to an organization's adoption of an EDI system because the information of such systems is highly shared among professionals [41]. Predictably, in the context of M-commerce—a popular subject matter commonly shared by IT professionals, an organization member's decision making process of M-commerce strategy would be frequently discussed among IT professionals; their discussion would result in professionalization as aforementioned and in turn create significant normative pressures to any organizational members in the field. Consequently, the higher the normative pressure perceived by an organization, the more likely it will adopt M-commerce strategy.

P3: the greater the normative pressures, the more likely a firm will adopt M-commerce strategy.

While normative pressures generally stem from the professionalization [9], they specifically manifest themselves in two patterns: informal information exchange and formal professional networks and associations. Informally, IT professionals are likely to cross the boundary

of organizations and exchange professional information in various social settings. Such boundary-spanning individuals often bring in new ideas and help initiate an innovation in the organization [42]. As these boundary-spanning individuals exchange information frequently, they would be highly aware of any emerging technology newly developed and adopted in other organizations in the industry [42]. Such awareness would be increasingly prevailing within the organization. The management would thus inevitably sense the obligation to upgrade the professional practice and services to better retain its IT professionals. In the context of information technology, better professional practice and services often denote better technologies implemented. The state-of-the-art technologies used in the organization indicate certain challenges to IT professionals and the organization's willingness to compete with other organizations at the same level. As such, the degree to which boundary-spanning individuals informally exchange information among one another will create normative pressures for the organization and eventually influence its adoption decision of M-commerce strategy.

P3a: the more the informal boundary-spanning activities, the more likely a firm will adopt M-commerce strategy.

Formally, boundary-spanning activities could evolve through professional networks and associations. Such formal professional networks and associations often organize seminars or training sessions to help diffuse newly developed ideas or technological innovations. Professionals who frequently attend such activities would obtain knowledge and/or skills of concurrent practice or technologies in the industry. The managers involved in such professional affiliations would also eventually "view problems in a similar fashion, see the same policies, procedures and structures as normatively sanctioned and legitimated, and approach decisions in much the same way" [9, p. 153]. These boundary-spanning individuals would eventually become change agents or IT champions in the organization [32] to advocate the innovation in a similar fashion that other boundary-spanning professionals would do in their organizations. In the context of EDI, the extent of participation in professional associations denotes certain normative pressures, which in turn influences the intention of EDI adoption [41]. In the context of M-commerce, such formal participation of boundary-spanning activities would also help IT professionals and managers to realize the state-of-the-art mobile technology. Their realization would inevitably create certain degree of normative pressures that eventually urge an organization to adopt M-commerce so that the competitiveness could be ensured.

P3b: the greater the participation of professional network/associations among its professionals, the more likely a firm will adopt M-commerce strategy.

II. 5 The Effects of M-Commerce Strategy

Institutional theorists argue that an organization makes

isomorphic changes to pursue for social fitness [9], cultural support [20], or ultimately institutional legitimacy [24]. Such pursuit of legitimacy will reflect on organizations' external reputation. For example, as a firm makes isomorphic changes toward a popular management technique such as total quality management (TQM), it might symbolically create an innovative vision for the stakeholders. This innovative vision might be due to any form of isomorphic pressures. Once it is created, however, the organization has declared to its stakeholders that it intends to compete at the same level as other organizations do. The stakeholders would then better recognize the organization as a legitimate competitor in the industry. An organization's image and reputation would then be enhanced regardless of the actual performance [37].

Considering the tremendous potentials of M-commerce [31] [34], an organization's strategic choice of M-commerce would then demonstrate its willingness to create new competing opportunities and its desire to compete with other organizations in the field. Such demonstration could then help enhance an organization's innovative image and competing legitimacy—in another word, its external reputation.

P4: the adoption of M-commerce will be positively associated with an organization's reputation.

While the adoption decision of M-commerce would affect an organization's competing legitimacy through the heightened external reputation, it would also improve employees' recognition of the firms simultaneously. Empirical studies have shown that as an organization makes an innovative decision such as implementing a popular management technique—TQM, the organization gains not just the stakeholders' but also the employees' recognition [37]. Particularly, if such a decision stems from the strategic responses to normative pressures, it would denote an organization's enthusiasm to fully equip the employees with superior technology and the state-of-the-art practices. As the professionals exchange information about the current practice of the firms, the employees whose firms have adopted M-commerce would then feel more confident and comfortable to diffuse such information. Other professionals whose firms have not yet adopted M-commerce would then better recognize and appreciate the practice of the adopting firms. Such recognition and appreciation would reflect on the adopting employee's attitude toward their adopting firms. As such, the employees whose organizations have adopted M-commerce would tend to better recognize their firms.

P5: the firm's adoption decision of M-commerce will be positively associated with its employees' recognition of the firm.

These propositions and relationships among constructs are illustrated in Figure 1 below.

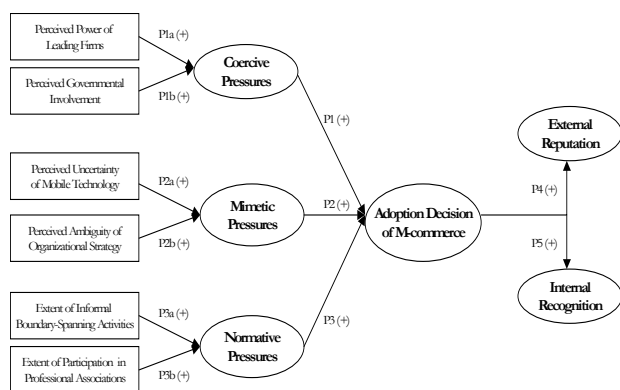


Figure 1. The Proposed Research Model

III. Methodology

The paper builds upon a theory testing approach. The purpose of such an approach is to obtain reliable statistical power and in turn generalize the results and allow replicability. To achieve these objectives, the survey method will be used to collect data because of the need of a large sample size across geographically distributed areas. In addition, structural equation modeling (SEM) techniques will be used to analyze data and test the proposed research model. SEM is best known for dealing with a theory-driven, confirmatory analysis of complex, multiple layers of relationships among underlying constructs [17], which suits the research model (Figure 1) that is strongly rooted in institutional theory.

The 1000 largest companies in the metropolitan area will be contacted as the potential participants. A solicitation letter will be first distributed to each of these companies' CIO or IT manager. An indication will be made in the letter to guide them fill out the survey online. Online survey allows autonomous and anonymous participation in a convenient fashion. It should better encourage the participation and facilitate the data collection process.

The Measures

Most items used on the survey are developed from conceptual definition because no existing instrument is specific enough to serve the purpose of the study.

Coercive pressures are measured by two sub-constructs: perceived power of leading firms (PPLF) and perceived governmental involvement (PGI). The former indicates the extent to which the leading firms impose coercive pressures on others. Such coercive pressures would particularly manifest themselves if an organization perceives that the leading firm possesses necessary technological and other resources to establish the standard or to well connect to governmental agencies and in turn lobby necessary changes in favor of them. As such, three seven-point scales will be

employed to assess a leading firm's technological, financial, and political resources (Appendix). Perceived governmental involvement, on the other hand, denotes the degree to which governmental agencies engage in the standardization of mobile technology, which is one of the main sources of coercive pressures. When a governmental agency regularly participates in industrial activities and/or promotes certain industrial or technological standards, coercive pressures would become more apparent. As such, two seven-point scales will be used to assess the degree of governmental agencies' participation in each of activities above (Appendix).

Mimetic pressures are measured by two sub-constructs: perceived uncertainty of mobile technology (PUMT) and perceived ambiguity of organizational strategy (PAOS). Perceived uncertainty of mobile technology mainly stems from technological standard and infrastructure issues [19]. Because many issues of technology and infrastructure development remain unsolved in the industry, an organization inevitably experiences difficulty to adopt M-commerce and tends to imitate other organizations. Perceived uncertainty of mobile technology, thus, would be measured by two seven-point scales assessing the degree to which the technology standard and infrastructure is perceived to continue to change in the near future (Appendix).

Perceived ambiguity of organizational strategy, in contrast, concerns an organization's business and IT strategy. While common business strategies are categorized as defenders, analyzers, prospectors, and reactors [29], IT strategy could be articulated by low cost and differentiation/innovation [33]. However, the concern of perceived ambiguity of organizational strategy does not involve the types of strategy but the degree to which the strategy is clearly illustrated in the organization. As such, the study would simply employ two seven-point scales; each of which assesses the degree of clarity of business and IT strategy, respectively (Appendix).

Normative pressures are measured by two sub-constructs: extent of participation in informal boundary-spanning activities (EPBS) and in formal professional associations (EPPA). Boundary-spanning activities could denote the contact through interpersonal relationships or with mass media [6]. The paper thus employs two seven-point scales to assess the degree of participation in each category of boundary-spanning activities (Appendix). In addition, the participation in formal professional associations indicates how much the professionals have been exposed to IT related professional activities. This notion resembles the construct of external participation in Brancheau and Wetherbe [6]. While these authors measure the number of networks and associations to which the professionals belong, this paper argues that a scale assessing the degree to which the professionals involved in professionals associations would be more appropriate because obtaining a membership is one thing, actively

involving in professional activities is another. The study thus employs one seven-point scale to assess the degree to which the professionals actively involve in professional activities (Appendix).

Adoption decision of M-commerce strategy is measured by the time of decision made (TDM) [6]. While some studies measure the adoption by intention (e.g., [41]), such measure is appropriate only when the action of adoption has not yet been undertaken. In the context of M-commerce, many large corporations might have implemented the technology and relevant competitive strategy [8]. As such, two seven-point scales that measure the past and the future decisions would better incorporate the decisions that have made and the intention to adopt (Appendix).

External reputation is measured by a firm's actual performance. The actual performance assesses a firm's changes in revenues. An increase of revenues indicates that the stakeholders have higher confidences on the firm so that the investment on the firm or the transactions with the firm increase. Such measure has also been used to signal a firm's reputation in the industry [37]. Rather than measured by the survey, the data would then be collected through public records such as the firm's quarterly or annual reports and/or financial performance in the stock market.

Internal recognition is measured by the turnover rate of employees. When the employees perceive that their firm could not provide equivalent practices or services as other firms do, they would be likely to leave for better opportunities. On the other hand, as they better recognize and appreciate the firm, they would tend to retain. The record of turnover rate would then be appropriate for the research context.

IV. Discussion

IT research has extensively applied economic-based theories such as transaction cost economics and resource-based view to explain the rationale of IT adoption (e.g., [3] [4] [11]). The former perceives IT as a tool to reduce cost while the latter views it as a valuable resource to provide competitive advantages. These theoretical perspectives stem from rational choice theorizing foundation in which an organization is assumed to be a rational actor who would act on rationally calculated purpose. Rational choice perspective, however, has been widely challenged because it fails to explain social and political factors emerging from the environment [18] [24] [37]. Social and political factors are important with respect to the technological adoption because they better explain environmental forces that lead to an organization's adoption decision [20] [22]. More specifically, this paper argues that isomorphic pressures help clarify an organization's action in adopting collective organizational practices in general [9] [28] and comparable technologies in particular [1] [41]. The findings of the study, thus, could

contribute to the organizational practice in the following ways.

First, since a regulated technological standard could create coercive pressures that force other firms to follow, developing and establishing a standard for mobile technology would become one of the most powerful weapons to help a firm compete in the emerging market. Organizations, thus, could seek strategic alliances or political cooperation to persuade governmental agencies to establish the standard of mobile technology. This could help dictate the institutional trend so that other firms have no option but comply with such standard. Second, the adoption of M-commerce needs to fit into an organization's strategy. Without a clear strategy, an organization would inevitably face mimetic pressures to imitate other firms' practices, particularly with many uncertain technological issues surrounding M-commerce. As such, to better compete in the emerging market and ensure survival chance, an organization needs to first develop a clear vision with respect to business and technological investments.

Third, an organization needs to renovate pressures into resources. Isomorphic pressures mostly result from institutional members in the field. If an organization could establish technological collaboration with these members or competitors, the competition resulting from isomorphic pressures could then be reduced. Such collaboration does not necessarily denote formal strategic alliance. Instead, it could imply an institutional network through which members exchange information and share experiences with respect to technological adoption. Finally, an organization might need to encourage its professionals and managers to actively participate in boundary-spanning activities. These boundary-spanning individuals could bring in new ideas and concurrent information of the field. Their informal interaction with other professionals in the field and formal involvement in professional associations could be developed into common practice in the firm. In the short term, such common practice could help an organization learn better approach of implementing M-commerce strategy; in the long term, it could further establish an innovative culture in the firm so that the organization would continuously improve its technological practice and establish an innovative legitimacy. Such legitimacy could, on the one hand, enhance an organization's survival chance and, on the other hand, help an organization to impose isomorphic pressures on other institutional members.

V. Concluding Remarks

While economic based theories such as transaction cost economics and resource-based view have been extensively applied, institutional theory offers a new dimension to examine IT phenomenon. Drawing from such a new dimension, the study seeks to examine an organization's adoption strategy of M-commerce in relation to isomorphism. Specifically, the paper proposes that each of isomorphic pressures would influence an organization's

adoption decision of M-commerce. Coercive pressures result from powerful organizations and governmental agencies' intervention in the standardization of mobile technology. Mimetic pressures are derived from the technological uncertainty and the ambiguity of organizational strategy while normative pressures rise from the professionalization through which boundary-spanning individuals involve in informal information exchange and formal experience sharing and training. These isomorphic pressures could motivate an organization to adopt M-commerce in a similar fashion as that of other institutional members.

Once the adoption decision of M-commerce is made, it denotes that the organization would join the competitive market much in the same way as other organizations do. The organization would then be better recognized by stakeholders as a legitimate player and by its employees as a better place for which they work. The heightened external reputation and internal recognition could consequently help enhance an organization's actual performance and retain its valuable professionals. To better compete and survive in the emerging competitive market, an organization would then need to pay strong attention to social and political landscapes of an institutional field so that a better strategic choice of M-commerce could be developed.

APPENDIX: The Survey Scales of Key Constructs

For all items: 7—strongly agree; 1—strongly disagree.

Perceived Power of Leading Firms (PPLF)

The leading firms possess powerful technological resources.
The leading firms possess powerful financial resources.
The leading firms possess powerful political resources.

Perceived Governmental Involvement (PGI)

The governmental agencies actively participate in the industrial activities.
The governmental agencies actively advocate certain standards for mobile technology.

Perceived Uncertainty of Mobile Technology (PUMT)

The standard of mobile technology will continue to change.
The infrastructure for connecting mobile technology will continue to evolve.

Perceived Ambiguity of Organizational Strategy (PAOS)

Our organization has a clear business strategy.
Our organization has a clear IT strategy.

Extent of Participation in Informal Boundary-Spanning Activities (EPBS)

I frequently contact other professionals in the industry for technological information.
I am actively exposed to mass media related to the technology.

Extent of Participation in Professional Associations (EPPA)

I actively participate in IT professional associations.

Time of Decision Made (TDM)

Our organization has adopted M-commerce for a long time.
Our organization intends to upgrade M-commerce soon.

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The Multi-Channel CRM Application Framework for M-Business Practices

Chian-Hsueng Chao

Department of Information Management, National University of Kaohsiung,
Kaohsiung, Taiwan, ROC
cchao@nuk.edu.tw

Abstract: In every industry, customers' preferences are changing faster than ever before. Customers can no longer be categorized into well-defined market segments or homogeneous groups. They need to be treated as individuals each with specific needs. The information must be available to anyone from anywhere at anytime. Therefore, service quality becomes an important measure for both enterprises and customers. In real-time economy, sales and services have deep impacts on up/downstream decisions, as well as decisions related to supply chain trading partners. Thus, customer relationship management (CRM) has more transparency than ever, by shifting from a sales productivity tool to a technology-enabled relationship management strategy. Today's businesses are typical collaborative multi-enterprise multi-channel supply chain consisting of several specialists. Mobile technology and personalized customer care open the door to new opportunities by offering value-add services in CRM practices. The key to customer satisfaction and loyalty resides in the enterprise's core offering and efficient transaction management. This paper provides a broad discussion on the design of mobile-to-enterprise application framework for CRM practices. The purpose is to provide an overview and schematic to design an integrated mobile CRM suite. The ideal of this approach is to maximize the value of an enterprise's customer portfolio through more efficient and effective marketing, sales, and customer service and to put the customers in control, by providing self-service and solution-centered support. With the mobile CRM application framework, the enterprise is also extended to suppliers and trading partners so that when customers get in contact with the resources of an enterprise, they also touch the resources of the value chain. The customers who drive the entire value chain (or supply chain), determine what is to be produced, when it is produced, and at what price.

I. New Dimension of Channel Integration

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. Whenever an innovation is introduced, it brings both new challenges and business opportunities to enterprises. The e-business comes a long way from hype to mature. The mobile solutions will build on the top of the existing e-business investments. The m-business is facilitated by the

integration of the Internet, e-business, and the wireless world where customers can go online with any device at anytime from anywhere [1]. Mobile businesses open up new opportunities for innovated enterprises and give them new means of communications with inside/outside stakeholders. In a changing business landscape, mobile business addresses new customer channels and integration challenges. 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 real-time economy, sales and services have deep impacts on up/downstream decisions, as well as decisions related to supply chain trading partners. Thus, in m-business era customer relationship management (CRM) has more transparency than ever, by shifting from a sales productivity tool to a technology-enabled relationship management strategy in a global supply chain scheme. The CRM is a combination of business process and technology seeking to profile an enterprise's customers from different perspectives [2]. It contains call center service and support, customer contact management, and sales/marketing automation that help to acquire/retain customers and eliminate operation inefficiencies by streamlining and unifying customer information and other internal/external inter-enterprise process integrations.

Enterprises focus on how to use mobile technology to provide customers with rich service experiences and greater satisfactions. Mobile applications are beginning to play a central role in enabling real-time CRM. Enterprise must design a mobile application framework for both customers and their suppliers. The usefulness of the mobile channels will be largely driven by new enterprise applications that enhance the overall customer values. Seeing m-business processes in terms of a net value added chain is a good approach for visualizing current and future competitive advantages. The creation of these values depends on the enterprise's ability to coordinate and link those internal/external activities efficiently.

II. The Mobile Value Proposition

As the global economy shifts toward the mobile economy, enterprises need to be progressively more flexible and globalize. The mobile business strategies will focus on what "value" might be created for the customers and enterprises in the marketplace. To gain competitiveness and create values, the enterprise should target on redesigning their core

business processes in response to key competitive factors. These competitive factors can be derived from the 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 1). 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. 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]. The usefulness of the mobile channels will be largely driven by new enterprise applications that enhance the overall customer values. A business that creates m-business applications can benefit from the first-to-market advantage.

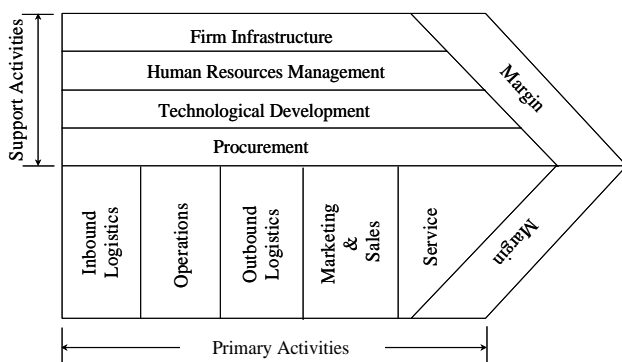


Figure 1. Porter's Value Chain (After Porter, 1985)

As the wireless Internet continues to expand, first-to-market organizations will have already secured a customer base. It can be foreseen that the m-business market value will be astronomical.

III. Customer Portal : One for All

As mentioned before, seeing m-business processes in terms of a net value added chain is also an approach for visualizing current and identifying future competitive advantages. In short, the creation of these values depends on the enterprise's ability to link and coordinate these internal/external activities efficiently [3]. This interconnected value chain system can act like a supply chain that encompass the modern business world, and participating organizations can readily extend their technologies to their partners.

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 [6]. 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, CRM 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 2). The applications of CRM, by definition, must automate processes across multiple user types and functional areas. CRM 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 CRM is to build an adaptive marketing strategy such that the entire selling process will be more active and flexible than traditional 4Ps (product, price, place, and promotion) marketing approaches allowing sales teams to better handle any sales activities.

The IP convergence strategy will provide a solution that joins the two worlds of voice communications (telephony) and data traffic together. Technologies, such as interactive voice response (IVR), computer telephony integration (CTI), are beneficial to CRM. The fully interactive nature of the Internet changes everything in the world of self-service.

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 CRM 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.

V. System Architecture

In today's m-business, competing for mobility requires either aligning one's strategy to what the enterprise agility or developing mobile computing capabilities to support a desired supply chain strategy. Mobile business systems must to address the strategic visions of enterprise. A successful mobile business application framework for enterprises should link supply chain management, relationship management, and knowledge management to function in an adaptive way and continue to thrive in the m-business era. The design of a m-business system needs to focus on collaboration. In the mobile CRM system architecture, several dedicated servers and databases are required, because enterprise must capture and retain in a central/distributed data repository the data and information that employees need (Figure 4). A CRM 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, and convenient self-service. Given the information customers need in the purchasing process. The reasons to stress on 3G/4G and include in this framework are (a) it has wider bandwidths, higher bit rates, (b) it support interactive multimedia services, teleconferencing, wireless Internet, etc., and (c) the global mobility and service portability. For knowledge management issues, the architecture of IT in the knowledge management system is concerned with organizing and analyzing information in an enterprise's database so this knowledge can be readily available throughout an enterprise. A central/distributed data repository that provides/captures the data and information for employees and executive decision-making is also very important in a knowledge management system. The database system is the driver that consolidates and directs the overall resources of the supply chain to the most mission-critical business activities. As a result, an m-business CRM solution must provide supports for the capture and communication of customer demand, as well as enable this demand to automatically trigger business events and initiate process workflow. Transcoding contents and developing enterprise applications to work across several mobile devices and

browsers seem to be a complex problem. The key is to focus on the lowest common denominator: the XML (eXtensible Markup Language) and XSL(eXtensible Style sheet Language). The XML supports for developing mobile applications running on multiple devices and platforms [7]. Databases are also working with XML-structured data and tabular relational data. The ability to translate standard HTML/XML content into the various flavors of wireless content is based on the way that the XML/XSL standards operate. Because of these standards, XML is able to function as a meta language, flexible enough to recreate other markup languages and use them as subsets. Technologies such as Java Server Pages (JSP) and Active Server Pages (ASP) are also being extended to support multimode clients. Figure 5 illustrates some examples of transcoding systems and applications. Enterprises that provide HTML to wireless transcoding solutions translate standard content into XML that reflects all of the information flow and logic of the transcoded content, and by browser detection determines for each mobile user which subset of XML to translate content into [8]. Thus we see that a robust and active transcoding system goes a long way toward reducing complexity and maintaining consistency throughout the enterprise across multiple clients.

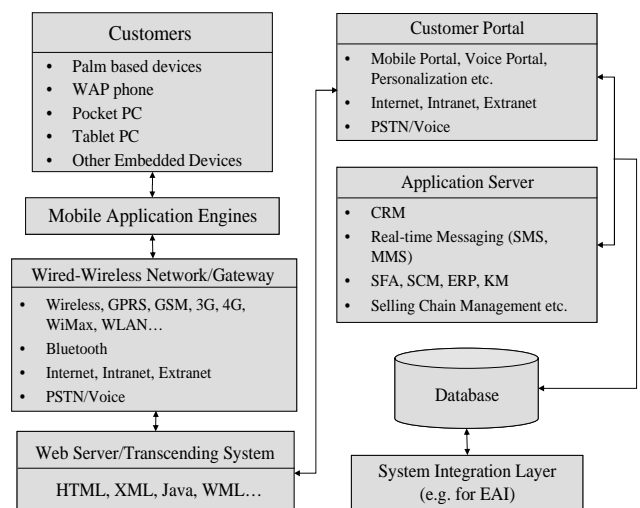


Figure 4. The Mobile Customer Portal System Architecture

Effective m-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 supply chain framework will offer virtually unlimited business opportunities in the alignment of technologies and processes. A well-designed and well-integrated supply chain for m-business will improve upon existing cost-responsive processes, and have organizational agility in the event of change.

VI. Conclusion

Multi-channel and multi-technology strategies represent the

next frontier of sales force integration. The mobile Internet will open an important new channel for commerce. 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 CRM.

Content in XML can use XSL style sheets to dynamically render the content into:

- HTML for Desktop and PDA
- HDML or WML for mobile devices
- Specific XML for B-to-B

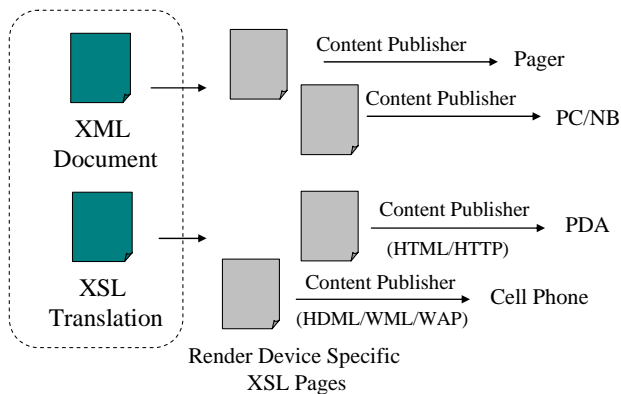


Figure 5 Content Transcoding and Delivery Scheme

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 integration of voice and data makes office solutions more flexible and easier to manage. Mobile Business opens up new paths to service-oriented information processing and optimizes internal and external communication.

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 CRM that reinvented itself from traditional sales/marketing strategies will undoubtedly be the best solution to today's e-business Internet marketing.

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Mobile Commerce Opportunities in the Airline Industry

Brian Masterson, June Wei
University of West Florida
11000 University Parkway
Pensacola, FL 32514

Abstract: Mobile commerce will provide opportunities to improve business values in the airline industry; however, it has been slowly adopted and has not been implemented widely. This paper develops a mobile commerce model for air travel companies that can be used to study features necessary to perform m-commerce using wireless devices. Twenty-eight interface features are identified based on this developed model. The implementation of these features for the existing web-based airline ticketing in the top ten airline companies are examined. These features are important to develop an efficient and user friendly mobile commerce for airline industry in the near future. The beneficiaries of the findings from the current research are the existing airline companies, future mobile commerce airline companies, and the developers of mobile commerce systems.

Keywords: Mobile Commerce, Electronic Commerce, Airline Industry, and Mobile Ticket

I. Introduction

Some might say that the U.S. domestic airline industry is on the brink of disaster. It is a complex situation, complicated by world events, economic forces, management and labor disagreements, national policy, intense intra-industry competition and consumer preference. The airline industry lost 15 billion in 2002 and 2003 and probably will lose 5 billion in 2004 (Will, 2004). Most organizations in the airline industry have attempted to respond to the financial turmoil through drastic evolution. Since the September 2001, the network or legacy carriers have scrambled to minimize losses by cutting jobs, eliminating routes, and decreasing infrastructure. Conversely, many of the low-fare airlines have increased routes, expanded hiring, and worked aggressively to gain market share by offering lower ticket prices. The low-cost carriers' share of the market has gone from 16 percent in the year of 2003 to 25 percent in 2004, and some analysts are predicting that they could account for as much as 40 percent of the market next year (Marks, 2004). The leadership at most airlines is now showing an understanding that despite the inability to control world events, positive results can be influenced through value chain analysis. By seeking ways to improve its value chain, the airlines have an opportunity to streamline production costs, improve customer service, and create a profitable market in spite of the global turmoil.

E-Commerce

Common to each of the above functional business areas is electric or e-commerce. E-commerce is as defined as the conduct of financial transactions by electronic means (Will, 2004). Essentially, e-commerce is about using the power of the Internet to make money. The airlines have all leveraged the power of the Internet to reach customers. In the past ten years, company websites have gone from an anomaly to a commodity.

Prior to the Internet boom, airlines relied heavily on ticketing agents and reservationists in order to sell and distribute tickets. Through company web pages, airlines are now able to sell and distribute tickets. Many airlines even offer discounts to customers who purchase their tickets online. "Today, airline tickets are one of the most popular items bought on the Internet worldwide, accounting for over a quarter of consumer online spending in the United States alone." (Hanke & Teo, 2003) Airlines utilize website technology to book passengers on flights, make reservations, check baggage, and expedite the boarding process. Through the expanded use of the Internet, airlines are able to reduce labor costs and in some cases eliminate commissions all together.

Technology and the Internet have been critical to the success of JetBlue. In 2003, 73% of all tickets were purchased through JetBlue's on-line website. Another 24.6% of tickets were booked through JetBlue's reservation agents (2003 JetBlue Annual Report). Unique to JetBlue is the fact that 100% of the company's reservation agents are part-time employees who generally work from home. To operate a traditional call center in the U.S. costs about \$31 per employee hour (including overhead and training). Conversely, home-based agents cost an average of \$21 an hour. "After wiring its agents' homes into its reservation system, JetBlue pays its agents starting wages of \$8.25 an hour plus benefits." (Whalen, 2004) The cost savings achieved by maintaining infrastructure (buildings, electricity, and employee benefits) are able to be passed along to the consumer in the form of lower fares.

The Internet also allows the airlines to reach new customers. Customer relationship marketing technologies are used to build customer relationships and improve profit margins. United Airlines launched United.com in 1997. In 2000, United created a separate e-commerce division within the organizational hierarchy that was "dedicated to maximizing the sale of travel products over the Internet and Internet-enabled devices." (Hanke & Teo, 2003) Many airlines currently use their own websites to market and sell

their use of technology to current and potential customers.

From E-Commerce to M-Commerce

Innovation and product differentiation through new products and services are critical in sustaining a significant competitive advantage (Hanke & Teo, 2003). The next opportunity for airlines to reach new markets, maintain low distribution costs, and enhance customer value can be achieved through the use of mobile or M-commerce technologies.

M-commerce can be defined as a transaction that takes place via wireless internet-enabled technology (through handheld computers, cellular phones, personal digital assistants (PDA), or palm) and that allows for freedom of movement for the end-user. Wireless fidelity (Wi-Fi), the transmission of short-ranged radio signals between a fixed based station and an end-user's mobile device, is the driving technology that facilitates m-commerce (Wireless computing, 2003). In 2003, 79 million users from around the world accessed the Internet via wireless technology. It was an increase of 145% from the previous year (Converging Markets, 2004).

II. Methodology

A Model for Web-based Mobile Commerce

The value chain as described by Michael Porter is an analytical tool used to identify and examine value-adding activities within the individual firm and between firms. The value chain is composed of primary and supporting functional business activities. Primary activities are those designed to bring the product, or service in this case to market. Primary activities include customer service before, during, and after-ticket sales. For the airline industry, typical five primary activities and their examples of IT adoptions value chain activities include (Huber et al. 2004):

Inbound logistics: passenger accountability, passenger security, etc. Examples of e-value chain for airline industry include Logistics Management Systems, Enterprise Resource Planning, and B2B E-Commerce

Operations: aircraft maintenance, aircraft availability, aircrew scheduling, etc. Examples of e-value chain for airline industry include Enterprise Resource Planning, and Computer Aided Manufacturing

Outbound logistics: baggage tracking, international and domestic passenger connection, frequent flyer mileage, etc. Examples of e-value chain for airline industry include B2B E-Commerce, B2C E-Commerce, Logistics Management Systems, Customer Relationship Management, Transaction Processing Systems, and Enterprise Resource Planning.

Marketing and Sales: Reservationists/travel agents, website management, promotions, fare pricing, etc. Examples of e-value chain for airline industry include B2B E-commerce, B2C E-Commerce, Customer Relationship Management, Transaction Processing Systems, and Enterprise Resource planning.

Service: Aircraft custodial care, customer support agents,

etc. Examples of e-value chain for airline industry include Enterprise Resource Planning, B2C E-Commerce, B2B E-Commerce, and Customer Relationship Management

The role of information technologies (IT) cannot be overstated as a key enabler of activities in the airlines' value chain. It demonstrates the functional areas that are influenced by effective IT.

Based on the analysis of the five primary activities of airline industrial value chain above, the current research analyzes the proliferation of tools designed to facilitate electronic and mobile commerce in the U.S. scheduled passenger airline industry. Specifically, the activities inside mobile airline ticketing system could be part of the primary activities inside airline industrial value chain described above.

Figure 1 presents a model for booking airline ticket using mobile devices that would be facilitated through the use of M-commerce technologies in order to increase business values in the airline industry. This model could all be accomplished while the customer is driving his/her car to the airport in order to catch the next flight. In Figure 1, there are eight steps:

Step 1. A mobile customer wants to book an airline ticket via a mobile device.

Step 2. The customer uses a wireless device to log onto m-commerce site of major airline that available.

Step 3. After evaluating the various flight options and their respective fares, the customer enters a personal identification number (PIN), credit card information (if not already on file), and selects his/her flight.

Step 4. The data is sent via encrypted signal to the respective airline to ensure that the seat remains available during the transaction process.

Step 5. The encrypted signal is simultaneously transmitted to the credit card company to ensure that sufficient funds are available and no account discrepancies are present.

Steps 6 and 7. Upon positive indication from the credit card company, the airline accepts the customer's travel request and issues a confirmation number.

Step 8. The confirmation number, m-ticket, m-receipt, and paper receipt are sent to the customer. A m-receipt is also sent to the credit card company. The customer can also get m-boarding pass through a wireless device.

Primary Features of Web-based Mobile Ticketing

Chun and Wei (2004) identified mobile ticketing features for air ticket agencies. In the current research, the focus is on mobile commerce in airline companies. The functional components in Figure 1 are mapped into features required for mobile commerce and presented in Table 1. Some of these features were modified and adopted from Chun and Wei (2004) for air travel agencies. By mapping the model developed in Figure 1 into features, there are twenty eight features developed in Table 1. In Table 1, there are four categories: basic attributes, customer relationship attributes, collaboration attributes, and m-commerce special attributes.

The customer relationship attributes depict features that are designed to increase customer value through convenience. The goal of these attributes is to build customer loyalty. Collaboration attributes imply the importance of strategic alliances and exemplifies the airlines' attempt to provide one-stop vacation shopping for prospective travelers. M-commerce special attribute depict possible characteristics and services offered to mobile customers.

Table 1 is also a compilation of the various features

available on airline web pages. They have been drilled down according to levels of sophistication and complexity. When selecting website content, it is critical that an airline chooses attributes are appropriate and that provide values to the customer served. Features in Table 1 contain basic or expected features that enable an end-user to view available flights and make a flight/fare selection. They are features designed to facilitate and simplify the transaction process.

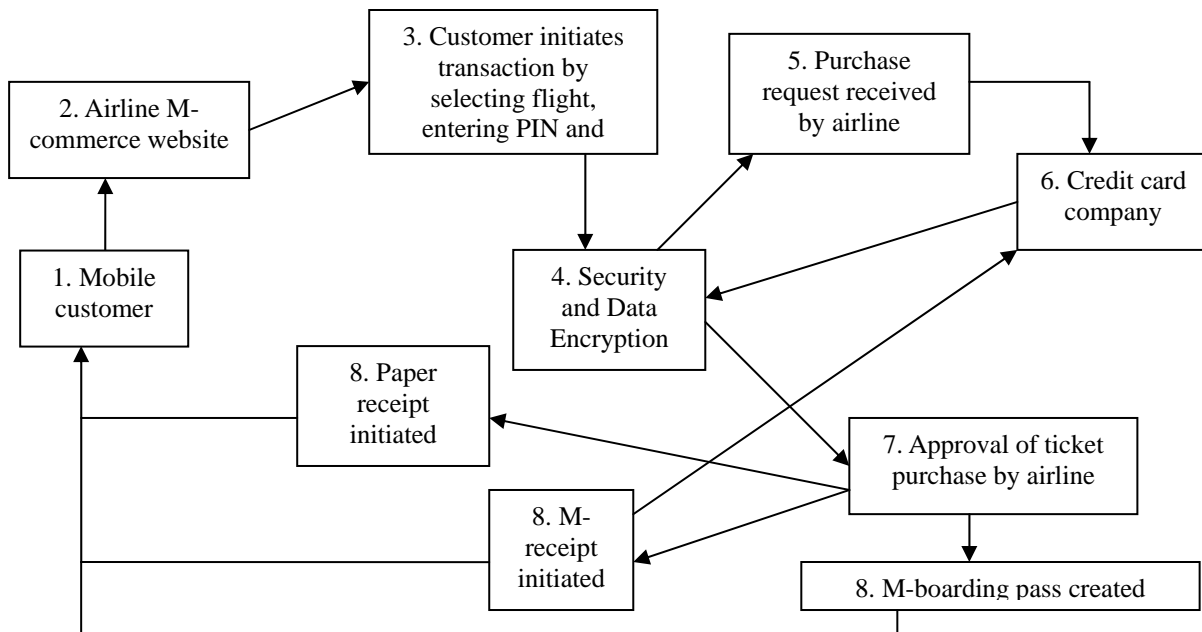


Figure 1. Typical M-Commerce Transaction

Table 1. Features for Mobile Commerce

Categories	Features	Feature Descriptions
Basic Attributes	A	Search begins at the homepage
	B	Dropdown menu available for the city code
	C	Dropdown calendar available
	D	Specific travel times can be chosen
	E	Both one way and round trip arrangements available
	F	Number of passengers traveling
	G	Point of contact phone numbers accessible within 1 click of homepage
	H	Domestic and International travel option
	I	Ability to select class of service (business, coach, etc.)
	J	Flights are sorted by price
	K	Both e-ticket and paper ticket offered
	L	Processing fee other than paper delivery charge is applied
	M	Source of credit card security is available
Customer relationship attributes	N	Membership is required to book tickets
	O	Memory function available to view "my account" information
	P	Redeemable coupons are available
	Q	Other options on similar schedules are available
	R	Frequent flyer miles from other airlines can be used

	S	Currency converter is available
	T	Travel itinerary e-mailed or faxed to passenger
	U	On-line check in offered
	V	Links available to destination weather forecast sites
	W	Airport maps/diagrams are downloadable
	X	Native language option available
Collaboration attributes	Y	Vacation packages available
	Z	Rental cars and hotel reservations links
	AA	Links to other websites (credit cards, etc.)
M-commerce special attributes	BB	Wireless ticket purchasing through wireless devices such as PDAs, cell phones.

Note: Some of these features are adapted from Chun and Wei (2004)

Table 2. Ranks of Airline Industry Leaders based on Market Shares (Corridore, 2004)

Rank	Year: 2004	Market Share (%)	Rank	Year: 1993	Market Share (%)
1	American	18.4	1	United	21.2
2	United	16.5	2	American	20.4
3	Delta	10.9	3	Delta	17.4
4	Continental	10.5	4	Northwest	12.2
5	Northwest	10.4	5	Continental	8.9
6	Southwest	7.5	6	US Airways	7.4
7	US Airways	5.7	7	TWA	4.8
8	America West	3.3	8	Southwest	3.5
9	Alaska Airlines	2.5	9	American West	2.4
10	JetBlue	2.3	10	Alaska Airlines	1.2

Table 3. Individual Website Attributes

Feature	American	United	Delta	Continental	North west	South west	U.S. Airways	America West	Alaska Airline	Jet Blue	total	%
A	X	X	X	X	X		X	X		X	8	80
B	X	X	X	X	X	X		X		X	8	80
C	X	X	X	X		X	X			X	7	70
D	X	X	X	X	X	X	X	X	X		9	90
E	X	X	X	X	X	X	X	X	X	X	10	100
F	X	X	X	X	X	X	X	X	X	X	10	100
G			X							X	2	20
H	X	X	X	X	X		X			X	7	70
I	X		X	X			X	X			5	50
J	X	X		X		X	X	X		X	7	70
K	X	X	X	X	X	X	X	X	X		9	90
L	X	X	X	X	X	X	X	X	X	X	10	100
M	X	X	X	X	X	X	X	X	X	X	10	100
N											0	0
O	X	X	X	X	X	X	X	X	X	X	10	100
P	X	X	X	X	X	X				X	7	70
Q	X	X		X		X	X				5	50
R	X	X	X	X	X		X	X	X		8	80

S										X	1	10
T	X	X	X	X	X	X	X	X	X	X	10	100
U	X		X	X			X				4	40
V											0	0
W			X								1	10
X											0	0
Y	X	X	X	X	X	X	X				7	70
Z	X	X	X	X	X	X	X	X	X	X	10	100
AA	X	X	X	X	X	X	X	X	X	X	10	100
BB		X									1	10
Totals	21	20	21	21	16	15	18	15	11	16		
%	75.0	71.4	75.0	75.0	57.1	53.6	64.3	53.6	39.3	57.1		

Data Collections

The U.S. Department of Transportation defines a major airline as one that has annual revenues over 1 billion. As of December 2002, the industry consisted of 83 large commercial air carriers. Of that total, 15 were major airlines (with annual revenues exceeding \$1 billion), 33 were nationals (\$100 million to \$1 billion), and 35 were mid-to-large sized regional airlines (\$20 million to \$100 million) (Corridore, 2004). Table 2 presents the airline industrial leaders based on market shares in 1993 and 2004, respectively.

The current study analyzes the features of these 28 features in the U.S. airline travel companies' websites that offer electronic airline tickets. M-commerce itself is a relatively new area and, undoubtedly, mobile airline ticketing is not yet available worldwide. As many scholars and industry analysts have claimed, mobile commerce is derived from electronic commerce (Coursaris et al 2003, Ozok & Wei 2003, Lee and Benbasat 2003); therefore, electronic airline ticketing that is more widely and popularly used should provide good guidelines on how mobile airline ticketing may be approached.

A total of twenty-eight features were gathered and tallied from the airline companies' websites, and the results are summarized in Table 3.

In Table 3, the websites of ten of the industry leaders in 2004 (Table 2) are examined. Almost unanimously from one company's website to another, the basic attributes are available. There is however several features that are used to help differentiate each website as well.

III. Findings

The findings based the features gathered from top ten airline companies' websites are tallied. First, the numbers of websites that provide each feature are tallied to find the most widely used features. Second, the numbers of features that various websites provide are tallied to analyze the versatility of those websites.

Website Features

In Table 3, the most widely used features are Features A, B, D, E, F, K, L, M, O, R, T, Z, and AA (80% or above) (thirteen features), which are usually found in the first search page, whether it is the homepage of the website or not. This observation clearly validates the importance of user-friendliness of the website's interface.

The least commonly used features are Features G, N, S, V, W, X, and BB (20% or below) (seven features). These features do not seem to be directly related to the immediate need of travel, explaining why those features are not very popular among websites studied. For example, Feature BB has been implemented by only one airline company, United Airline. Even though this feature is important and has potential benefits, it still not been widely adopted.

The rest of the other eight features are Features C, H, I, J, P, Q, U, and Y (eight features), which were implemented by some companies (between 20% to 80%). For example, Feature P, "Redeemable coupon" is not as ubiquitous as other features, but it may attract mobile customers, as both e-commerce and m-commerce get more popular.

Website Versatility

Ten airline companies' web sites are studied for the current research. In Table 3, out of these twenty-eight features available, all websites studied for these top ten airline companies have at least 11 or more of the features that are implemented. All these ten airlines have implemented above 50% for these twenty-eight features, except only one airline company, Alaska Airline, which implemented about 40% (lower than 50%) for these twenty-eight features.

Four companies that have implemented features more than the others (above 70%) are American, United, Delta, and Continental airlines. Out of these top ten airline companies, only the United Airline offers mobile ticketing.

IV. Discussions and Conclusions

The current research developed a mobile commerce model for the airline industry and studied the existing e-commerce environment, with a focus on web-based ticketing. The findings from the current research indicate that developing user-friendly m-commerce features is crucial to the success of m-commerce. There are some major findings from the current study.

First, it is not the number of features but the usefulness of the features that is critical to the success of the m-commerce. Thirteen features are most widely used features that were available at 80% or over of the websites, while seven web features were available at 20% or less than of the websites. All airline companies' web sites studied in the current research have at least 15 features, except for Alaska Airlines with 11 features. However, some airline companies streamlined the features better than others so that the users can get the information they want faster than they could have done on other websites.

Second, understanding socio-psychological aspects of m-commerce customers is essential to the success of m-commerce (Palen & Salzman 2002, Lee and Benbasat 2003). To coincide the speed and the ubiquity of m-commerce, the customers of m-commerce are almost always on the go and less patient than those of e-commerce. Therefore, the ideal m-commerce must be able to not only attract new customers but also beat the distractions that are also competing for the user's attention (Chun and Wei, 2004).

Third, the airline industry is just beginning to expand into the Wi-Fi (Wireless Fidelity) arena. United Airlines has recently made m-commerce features available to the general public. Among the m-commerce attributes offered on its website www.united.com, are the ability to book a flight, view personal itinerary, and receive electronic notification of flight status all via a web-enabled cellular phone or through wireless PDA. It even sends electronic boarding pass with bar-code identification. The bar code can be read directly from the passenger's PDA or cell phone using the same machinery currently in use to verify paper boarding passes.

To date, several airlines (Cathay Pacific, Lufthansa, and British Airways) offer passengers the opportunity to access the Internet while in-flight (Shifrin, 2003). Currently, the FAA has not approved the use of in-flight Internet onboard aircraft flying over the United States. However, many airports in the U.S. have established Wi-Fi "hotspots" that enable travelers within the airport to log on to the Internet without the need of a data port.

Despite the current legal prohibitions that restrict Internet access while airborne, m-commerce technology should be on an airline's radar. Business and leisure travelers

alike are rapidly becoming "tech savvy" and would achieve real value through the ability to purchase airline tickets without being tethered to a Local Area Network. In most cases, m-commerce capabilities are in line and consistent with current information systems infrastructure.

The next generation of the Internet enabled commerce is already here. Mobile commerce presents a multitude of opportunities for airlines to expand to new markets, reduce administration expenses, and lower operating costs. It affords airline passengers the freedom to travel effortlessly. No longer are passengers forced to wait in long lines at the airport. Passengers with on the go lifestyles can continue to travel while on the go and not miss a beat.

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User Acceptance of Mobile Payments: A Theoretical Model for Mobile Payments

Jiajun Jim Chen, Carl Adams
University of Portsmouth, Portsmouth, PO1 3AE, UK

Abstract: Mobile payment refers to the use of mobile devices to conduct payment transactions. Users can use mobile devices for remote and proximity payments; moreover, they can purchase digital contents and physical goods and services. It offers an alternative payment method for consumers. However, there are relative low adoption rates in this payment method. This research aims to identify and explore key factors that affect the decision of whether to use mobile payments. Two well-established theories, the Technology Acceptance Model (TAM) and the Innovation Diffusion Theory (IDT), are applied to investigate user acceptance of mobile payments. Survey data from mobile payments users will be used to test the proposed hypothesis and the model.

Keywords: mobile payments, user acceptance, TAM, IDT, LISREL

I. Introduction

Recent developments in mobile/wireless communication technologies have changed our daily lives. For example, we have enjoyed a high penetration rate of use of mobile devices, and the growth of usage of mobile devices has had a positive impact on the promotion of mobile commerce applications [1]. This phenomenon has happened in e-commerce, when Internet use was increasing worldwide. Forrester Research predicts that the total revenue from European Online Retail will quadruple to €67 billion between 2004 and 2009 [2]. However, there are still many unresolved issues in e-commerce applications such as security, privacy issues, and usability. These have long been an obstacle for further business growth [3-5]. Thus, it is extraordinarily important for service providers to understand these issues from the consumers' perspective, when developing mobile commerce applications.

New wireless and mobile technologies offer various mobile applications. Mobile payment is one of the fastest growing services. The business applications of mobile payment include parking tickets, vending machines, points-of-sales, and digital content. Plenty of different industry sectors have become interested in mobile payments. At the moment, one of the problems with mobile payments is the lack of standards and regulations. Mobile payment can be implemented via different solutions, such as premium SMS, infrared, RFID and so on [6]. These solutions claim to offer easier, faster and more secure methods than do competing solutions, though this is arguable. There are still issues

concerning the roles and responsibilities of various market participations and their implementation. On the other hand, consumers and merchants have the potential to influence the adoption of mobile payment.

Mobile payment is a sub-set of mobile commerce, and it plays an important role in mobile commerce applications. From the consumers' point of view, service cost is one of the major concerns determining use of mobile payment. This principle can even be applied to any new services [7;8]. It is likely that cost will be one of potential factors influencing consumers' decisions regarding mobile payment usage.

As mentioned above, privacy is another concern for consumers' confidence regarding the use of e-commerce [9;10], especially in financial transactions. This concern will have a similar impact on mobile payment, because they share the same payment transaction method, non face-to-face payment transaction. Consumers will not feel safe, as they cannot physically view and examine the actual transactions [11].

The popularity of the use of mobile devices and the potential market for mobile payment applications, demonstrates a vital need to identify and understand the determinants of consumer acceptance of mobile payments. There is little empirical evidence and research into mobile payment adoption, such as what determinants influence user acceptance of mobile payments. It is beneficial to research mobile payment systems as new technologies are waiting for user adoption. Therefore, this research will propose an integrated model. The theoretical model adopted the TAM and the IDT in order to determine consumer acceptance of mobile payments.

II. Theoretical Framework

This research's theoretical constructs are based on the TAM and the IDT. Using these two well-established theories has helped in building a rigid theoretical foundation for this research. They are two of the most influential theories in clarifying and predicting users' acceptance and adoption in a new system.

II.1 Technology Acceptance Model (TAM)

Davis (1986) developed the TAM model to explain user acceptance of new computing technologies in the organisation context. This model was drawn from Theory of Reasoned Action (Ajzen and Fishbein, 1980). The model suggests users' behavioural intentions to determine actual system use, and users' attitudes toward using influence users' behavioural intention. Moreover, perceived usefulness and perceived ease of use have affected users' attitudes toward use. TAM is a powerful theory to predict user acceptance of

technology. Some empirical tests have demonstrated that TAM is a robust model for Information Technology [12;13]. Since then, TAM has been widely used to conduct technology acceptance behaviours regarding different aspects of Information Technology [14-17]. TAM could be a tool to analyse consumers' intentions toward acceptance of mobile payments. Furthermore, numerous of e-commerce related researches have adopted TAM, in order to investigate how to achieve consumers acceptance in e-commerce [15;18].

The TAM model includes two important factors, perceived usefulness, and perceived ease of use. Perceived usefulness refers to "the prospective user's subjective probability that using a specific application system will increase his or her job performance within an organization context," and perceived ease of use describes "the degree to which the prospective user expects the target system to be free of effort" [13]. The TAM model has been widely adopted and verified [13;19;20]; moreover, many researchers have customised the model, so that it fits for different contexts [21;22].

Perceived ease of use

A successful user interface design has potential implications concerning the perceived ease of use to the users. Can users pay easily and quickly? The system providers have to consider this question, in order to ensure users can use the systems effortlessly. Usability has been widely used to evaluate information systems [23-25]. For example, in software products, usability looks at operations, design, and layout to evaluate how easy software would be for users to use and make it do what they want.

Research in usability has been conducted for over a century. For mobile applications, it is important to understand and improve the usability of mobile device interfaces [26]. Moreover, mobile applications raise new challenges and issues for system developers. Mobile devices have unique characteristics, such as screen size, screen resolution, input methods and so on.

In e-commerce applications, there are established guidelines available concerning design and which implement several web components for e-commerce application. However, there is limited guidance for design in mobile applications, especially mobile commerce. Design and usability guidelines are for e-commerce applications that are not compatible with mobile applications [27]. Therefore, it is crucial to understand how users interact with mobile devices, and what is important to users when using mobile applications.

In order to design and implement an easy to use application, the characteristics of the systems need to be understood. An easy to use interface is important for any application, especially for mobile applications [28]. This is because of the unique characteristics of mobile devices, such as screen size, input mechanisms, battery consumption and so on. Systems developers have to give serious consideration to design guidance for mobile applications.

Perceived usefulness

Davis et al. (1989) have concluded that perceived usefulness may be defined as the way in which a particular system could enhance users' job performance. Within the mobile payment context, people are normally looking for convenience, speed, and other rewards for using the systems. A system classified as high in perceived usefulness would lead to a positive user acceptance relationship.

II. 2 Innovation Diffusion Theory (IDT)

Before an innovation can successfully appear in the commercial market, a lot work is required to convince the potential adoptors. Individual users will make a decision whether to adopt an innovation, and this is based on knowledge and on the performance of an innovation [29-31]. Moreover, the speed of the adoption is also affected by potential adoptors' knowledge and experience of an innovation, and the knowledge and experience of their close friends and family [30;32-34]. On the other hand, different adoptors have different approaches toward an innovation. Some adoptors will use new products or services as soon as they receive it. Other adoptors may wait and see; if they are not convinced by the services, they will not accept them until they feel comfortable with them [35].

Rogers (1963) presents IDT for user adoption. This is a well-established theory, and many researchers have adopted this theory for their research [36;37]. The theory identifies the innovation decision process, and it assists in the adoption rate of innovation. Users' acceptance and use of new technology or goods are two key elements in IDT (Zaltman & Stiff, 1973), and help achieve the likelihood of an innovation adoption and the process of innovation decision. Rogers (1995) concludes that five factors could explain new technology's adoption: relative advantage, complexity, compatibility, trialability, and observability.

Relative Advantage: the degree to which an innovation is perceived as better than the existing product.

Complexity: the degree to which an innovation is perceived as being difficult to understand and use.

Compatibility: the degree to which an innovation is perceived as consistent with existing values and experience of the potential adoptors.

Trialability: the degree to which an innovation can be experimented with before adoption.

Observability: the degree to which the results of an innovation are observable to others.

As stated above, these five attributes have been identified as innovation adoption rate's predictor [30;35]. Rogers (1995) concludes that these five attributes influence the potential adoptors' attitudes and intentions during the adoption process. However, Rogers (1995) also emphasises that the attributes are conceptually different. The following section presents more details of these five attributes for innovation diffusion.

Relative advantage

The potential adoptors' can gain an economic and social advantage, if an innovation is undoubtedly advantageous [30]. Unsurprisingly, the potential adaptors realise that the new products or services are more advantageous and useful than existing similar products or services, it can be predicted that they will accept it. Mobile payments are likely offer relative advantage services for consumers. For example, use of mobile phones is seemingly became part of our daily activities, where the device is not only a communication tool, but also an electronic wallet [6]. Mobile phone users can benefit from using wallet-enabled phones. If mobile payment is really advantageous for users, then mobile payment's relative advantage should have a positive effect upon users' intention toward mobile payments.

Compatibility

When an innovation provides alternative or supplementary products or services, and little effort is required to learn operations or behaviour change, potential adoptors are likely to accept it [30]. Using mobile payment systems only require understanding operation procedures and application areas, and it does not change users' behaviour with payment activities. Therefore, mobile payment compatibility should have a positive effect upon users' intentions toward mobile payments.

Complexity

When an innovation's design is sophisticated and complicated, the potential adoptors require more knowledge and instructions to operate or understand the products or services. If this happens, the adoption rates of innovation will probably be disrupted [34]. Mobile payment service is not a complex innovation, and it aims to provide an alternative and convenient payment service for consumers. Therefore, service providers have to consider system usability, and offer a simple solution. Subsequently, mobile payment complexity would have a negative upon users' attitudes toward mobile payments.

Trialability

An innovation allows users to try a product or service. If this innovation meets an individual's requirements, such as cost, quality of service and so on, then they are likely to adopt it. Otherwise, they will simply reject it. Mobile payment trialability, therefore should be related positively to individual users' intentions toward mobile payments.

Observability

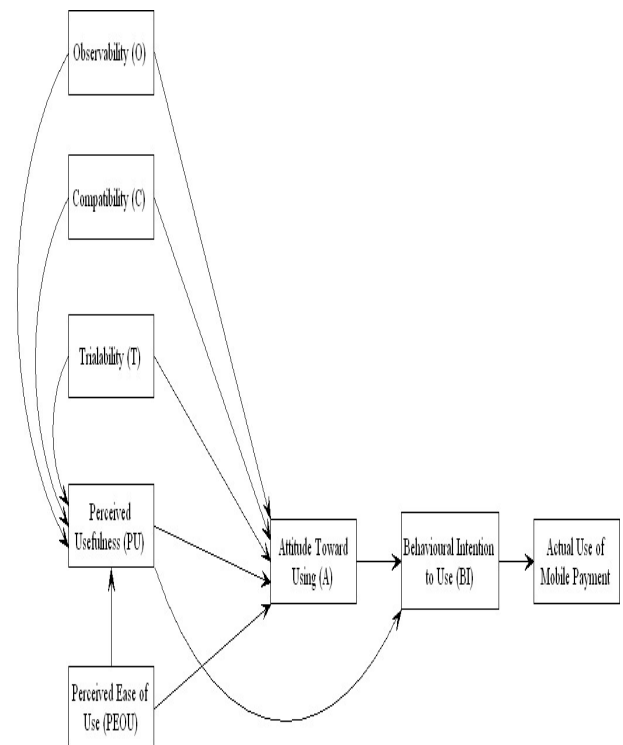
Innovations that are not easily observable have potential diffusion and adoption issues [35]. An innovation should attract the attention of the targeted user group, in order to make them aware of the service. Mobile payment is in a good situation as, when a mobile payment user uses the services in the public, it helps the service providers circulate services. This is because the potential adoptors can readily observe the innovation. Thus, the degree of mobile payment observability should have a positive effect upon users'

intentions toward mobile payments.

These attributes of IDT permit examination of the potential adoptors' decision making and are able to predict the future of innovations [30]. TAM and IDT have shown similarity in some constructs. Relative advantage is very similar to perceived usefulness in the TAM, and complexity is often viewed as the equivalent of the perceived ease of use construct in the TAM [38]. Previous researchers have combined these two theories, in order to offer a more powerful and acceptable model than the individual model [39], as shown in Figure 1.

In order to enhance consumers' enthusiasm for mobile payments, the mobile payment industry has to address the obstacles. For example, the European Central Bank has published guidelines for implementing mobile payment systems in Europe [40]. These potential factors will be incorporated as the antecedents of user acceptance of mobile payment systems as they have been considered relevant for mobile payment adoption.

Figure 1. A theoretical model for user acceptance model of mobile payments



III. Research Model and Hypotheses

A user's attitude has a significant impact on his/her behavioural intentions [41;42]. Previous research has suggested that, when conducting research into usage intentions, attitude will be accepted as a more accurate predictor in research, especially in studies on electronic, digital, and wireless channels (Bobitt & Dabholkar, 2001). Moreover, a user's actual use will depend on his/her

intention. These assumptions lead to the following hypotheses:

H1: A user's behavioural intention towards using mobile payment services has a positive effect upon his/her actual use of mobile payment services.

H2: A user's attitude toward using mobile payment services has a positive effect upon his/her intention to use mobile payment services.

In the TAM model, perceived usefulness can be interpreted as being the way a system could enhance a consumer's job performance [13]. Mobility is one of the main features that mobile services offer to consumers. In theory, consumers can access the services wherever they are. Perceived usefulness may have a positive effect upon the attitude towards mobile payment services [12]. Thus, in the context of a mobile service, perceived usefulness could be considered as how consumers' view mobile payments can be integrated into their daily lives [43]. If consumers gain a more positive view of mobile payment services, they will have a positive attitude and intention toward the services. Therefore, the following hypotheses are proposed:

H3: A user's perceived usefulness of mobile payment services has a positive effect upon his/her intention to use mobile payment services.

H4: A user's perceived usefulness of mobile payment services has a positive effect upon his/her attitude toward using mobile payment services.

Perceived ease of use is another key element in the TAM model and is concerned with the extent of users' belief that a system is easy to use, to set up, or to learn [13]. Mobile applications have different environments and contexts compared with e-commerce applications, and they can offer a complex service. Perceived ease of use may have a positive effect upon the attitude towards mobile payment services, and have a positive effect upon the perceived usefulness [12]. This leads to the following hypotheses:

H5: A user's perceived ease of use of mobile payment services has a positive effect upon his/her attitude to use mobile payment services.

H6: A user's perceived ease of use of mobile payment service has a positive effect upon his/her perceived usefulness of mobile payment services.

When an innovation provides alternative or supplementary products or services, and little effort is required to learn operations or behaviour change, potential adoptors are likely to accept it. Using mobile payment systems only require understanding operation procedures and application areas, and it does not change users' behaviour with payment activities. This assumption leads to the following hypotheses:

H7: Compatibility between a user using mobile payment services and a user's beliefs, values, and needs has a positive effect upon his/her attitude to using mobile payment services.

H8: Compatibility between a user using mobile payment services and a user's beliefs, values, and needs has a positive effect upon his/her perceived usefulness of mobile payment services.

An innovation allows users to try a product or service. If this innovation meets an individual's requirements, such as cost, quality of service and so on, then they are likely to adopt it. Otherwise, they will simply reject it. Mobile payment trialability, therefore should be related positively to individual users' intentions toward mobile payments.

H9: Mobile payment services' trialability has a positive effect upon a user's attitude to using mobile payment services.

H10: Mobile payment services' trialability has a positive effect upon a user's perceived usefulness of mobile payment services.

An innovation should attract the attention of the targeted user group, in order to make them aware of the service. Mobile payment is in a good situation as, when a mobile payment user uses the services in the public, it helps the service providers circulate services. Therefore, the following hypotheses are proposed:

H11: Mobile payment services' observability has a positive effect upon a user's attitude to using mobile payment services.

H12: Mobile payment services' observability has a positive effect upon a user's perceived usefulness of mobile payment services.

IV. Research Methodology

IV.1 Measure development

Survey has been selected as the central research methodology in this research. The multi-item scales measure was applied to this research in order to test the proposed research model. The statements are written for each item, and the participants were required to indicate whether they agreed or disagreed with the statements on a Likert scale. Many measures could be used in the TAM based research. For example, performance, productivity, effectiveness, usefulness, and time saving can be used to measure perceived usefulness. Moreover, ease of learning, ease of control, ease of understanding, ease of use, and flexibility of use can be measured perceived ease of use. Some of the items in the survey were taken from previously published scales with appropriate psychometric properties research, as shown in the following table; moreover, all of the items were adopted to fit the context of mobile payments. After an extensive literature review on the topic, new items were also developed.

This section will describe the development of the list of items by constructs.

Actual use of a mobile payment system. Consumers' frequency of use of a mobile payment system is considered a vital element for this research. Ajzen & Fishbein (1980) recommend measuring how often the system is used and approximately how many times it is used over a given time. Some researchers have employed this method ([12;13]. Applying this method to the research, the participants will be asked to record how frequently they use a mobile payment system on a 5-point Likert scale ranging from "Very

Frequently” to “Very Rarely”. The participants using services will then be asked how many times they have used it, based on 5-point Likert scale from “1-9 times” to “Over 40 times”.

Behavioural intention to use a mobile payment service. One question has been designed to ask participants the probability of their using a mobile payment system. This is because Ajzen & Fishbein (1980) identify that actual use is influenced by behavioural intention.

Attitude toward using a mobile payment service. Users’ attitudes can be deducted from their essential beliefs [41], and several research studies have used this principle extensively [13;44]. This research will follow this procedure to measure users’ attitudes. The items are adopted from previous research [12;43], and refined for mobile payment context.

Perceived usefulness of a mobile payment service. The items used to measure perceived usefulness are adopted from previous research with the contents having been refined to match mobile payment services [12]. Based on the findings of Davis et al. (1989) concerning perceived usefulness, this research argues that using the mobile payment will enhance users’ daily activities.

Perceived ease of use of a mobile payment service. The items for perceived ease of use are also developed from previous research [12]. Davis et al. (1989) conclude that perceived ease of use refers to whether a system is easy to learn or to use.

Compatibility. The items for measuring compatibility are adopted from Moore & Benbasat (1991) and Eastin (2002). Rogers (1995) concludes that identifying the compatibility of users’ needs, existing values, and beliefs with the new technological innovation is one way to evaluate the compatibility.

Trialability. A three-item scale is also adopted from Moore & Benbasat (1991) and REF. Rogers (1995) explains that an individual trying out an innovation is one way for a user to understand the system and how it works. The IDT suggests that trialability assists innovation to be adopted more rapidly than if the innovation does not have trialability [30].

Observability. Again, the items for measuring observability are adopted from Moore & Benbasat (1991) and REF. Rogers (1995) asserts that if the results of innovations can easily be shown, users are more likely to adopt the innovations. Mobile payment is a relatively recent innovation for most of the consumers, and it is probable that the systems’ observability will increase the adoption of mobile payment systems.

IV. 2 Data Collection

Mobile payment users are the target participants for this survey, which does not necessarily suggest that the participants have adopted the services. They are invited to participate in the survey online. In the survey, the participants have to consider one particular mobile payment scheme that they used during last three months.

The questionnaire collects two major types of information. The first part concerns participants’ demographic information, and the second part is about participants’ perceptions of each of the constructs in the proposed model. The demographic information includes gender, age, level of education, and occupation. The rest of the questionnaire asks for participants’ the opinions of each item.

In order to collect the data for this study, the survey signed up with an academic purpose survey organisation, which owns a mailing list of over a thousands users who occasionally participate in online surveys.

IV. 3 Data Analysis

Following the response from the online survey, the proposed hypotheses will be tested. SEM based analysis techniques will be used to analysis the data. First, the Confirmatory Factor Analysis (CFA) will be employed to assess the validity of the measurement for the model then the proposed model will be tested using the Structural Equation Modeling (SEM), so that the causal structure of the model can be evaluated. The research will use LISREL 8.7 to analyse the measurement model and the structural model.

V. Conclusion

This study is developing and investigating an in-depth understanding of consumer behaviours and motivations regarding mobile payments. Mobile payment is a new and emerging service in the market, and research in this area is required to identify the issues and opportunities for this service, in order to provide opportunities and guidelines for its diffusion.

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Account Based Mobile Payment by Diffie-Hellman Key Exchange Protocol

Kuen-Liang Sue, Wen-Jr Wu

Department of Information Management, National Central University

Jhongli City, Taoyuan County, Taiwan

Tel. +886-3-4267270

EMAIL: {klsue@mgt.ncu.edu.tw, 93423037@cc.ncu.edu.tw}

Abstract: With the development on techniques of mobile communication, the daily activities benefit from these techniques more than ever. In order to make living more convenient, the mobile payment has been brought up in recent years. The consideration for carrying out the mobile payment is very different from that in the wired electronics payment scheme because of the characteristics of mobile device. In this article we develop a mobile payment scheme that is based on reducing the operation of the device, and furthermore achieves the demands of security. It can create the session key for each transaction by means of using the "Diffie-Hellman key exchange" protocol. The use of the Message Authentication Code (MAC) can achieve the integrity of electronic commerce. Both of them do not need a large number of operations and complex algorithm so it can achieve the purposes of this investigation: a secure, convenient and light-computation scheme for mobile payment.

Keywords: E-finance, Mobile payment, Authentication code, Key exchange

I. Introduction

Along with mature and widespread development of the internet technique, more and more people enjoy the convenience of the Internet. It also expands the consumer market rapidly expand, and many business services also have been brought on the Internet. These businesses activity working on the internet can be general named as E-Commerce.

Like many commercial services, the most important action is the payment after consuming on the internet. As a result, the electronic payment plays a very important role in the electronic commerce. Many electronic payment schemes have been implemented, and these electronic payments are not only adopted in the virtual store on the internet but also applied on the real store, such as CyberCash[1], Paybox[2], Mobipay[3], Sonera Shopper[4] and Paypal[5].

In the recent years, because of the rapid development of the mobile communication network, the mobile communication network is no longer limited by transmitting the traditional voice data, and the data transmission on the mobile communication network also has been carried out. In the technique aspect, the data transmission rate on the mobile communication networks also increases continuously.

Nowadays the data transmission rate in the 3G system also comes to 144 kps. Those techniques development make business activities execute on the mobile communication network. The business activities on the mobile communication network can be named for mobile commerce. People will be able to use the mobile device to purchase the product or service. However, in a business activity, payment is an essential process. It is no doubt that payment is also an essential process in the mobile commerce.

However, unlike wired environment, there are many restrictions in the wireless environment. First, in wireless environment, the bandwidth is lower than wired environment, and the transmission error rate is higher. It also makes long latency. Secondly, the power of mobile device is limited. The memory and operation abilities are much weaker than the desktop computer. If we transplant current e-payment scheme which has implemented on the wired environment directly to the wireless environment, undoubtedly there will be many problems.

In this paper, we propose an account-based mobile payment scheme applied in wireless environment. The purpose of this scheme depends on reducing the computing quantity of mobile device. Thus, it can match the characteristics of the mobile device which are addressed on the above section. In the security of transmission, we don't use the SET[6] or iKP[7] because of reducing the computation load and the communication overhead. Another reason is to overcome the restrictions of mobile device and reduce the influence of the high transmission error in the wireless network.

The organization of this paper is introduced as following. In section 2, we introduce the related technique using in our proposed scheme. In section 3, we will introduce proposing mobile payment scheme. In section 4 we will discuss and evaluate the security of our scheme from different points of view. In section 5 we give conclusions.

II. Background

II.1 Public key and secret key cryptography

The cryptography in the communication can be classified into two categories. One is public key cryptography; another is secret key cryptography. The next sections will describe the features of them respectively.

The public key cryptography is also known as asymmetric cryptography. It uses different keys to encrypt and decrypt the communication data. The private key is only known by the sender, and he uses this key to encrypt the data

which he wants to send. The receiver uses the public key which was published from the sender for everyone to decrypt the data encrypted by sender. Each user in the network needs to have two keys: a public key which is available for anyone; a private key which the sender will keep by her/himself. It also needs a trusted third party to manage the key and verify whether the key is valid or not. The drawbacks of this cryptography are time-consuming, and the computational overhead of device is heavy. There are many known public key cryptography, such as RSA[12], DSA[14] and ECC[13].

The secret key cryptography has also been known as symmetric cryptography. It uses the same key to encrypt and decrypt the communication data. All participants joining this system have to trust completely and each participant preserves a key copy of other participants. Sender and receiver have to share the same key before communication. In the process of generating the secret key, the relevant information of generating keys has to guarantee against eavesdropping. It can achieve through assigning the secure gateway. Once the secret key is obtained by the third party, the data of communication does not be protected and becomes very dangerous. The advantages of secret key encryption are that the encryption time of symmetric cryptography is shorter than public key cryptography and this cryptography suits for encrypting a large amount of data. There are many known secret key cryptography, such as DES[15], AES[16] and RC5[17].

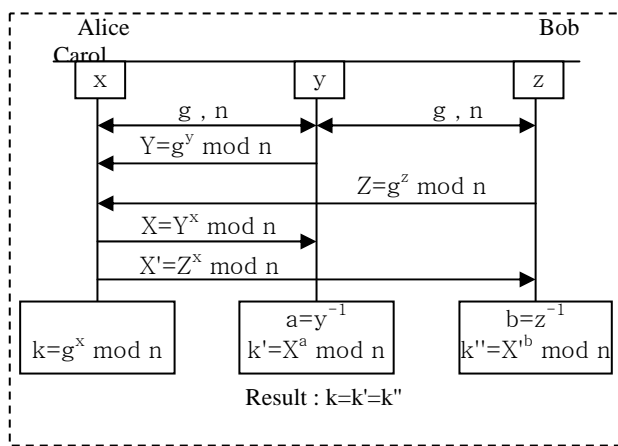


FIGURE 1. Process of three way exchange key

II. 2 Diffie-Hellman key change scheme

“The Diffie-Hellman key exchange scheme” is the first and well-known key distribution system invented in 1976, in which a common key could be established between two parties.[8] By using this key exchange scheme, communication parties can generate session key that needs to be used in the communication session. Generating a session key is very easy through this key exchange scheme, and can be completed without using complex algorithm. So it is suitable for using this algorithm in the small equipment

which only has low computation capability, like mobile device.

II. 3 Extension of Diffie-Hellman key exchange scheme

Based on *Diffie-Hellman key exchange* scheme, we can extend the two parties exchange key to three parties [9]. The Figure 1 shows the process of exchange key among three parties. The detail is described below.

First of all, Alice, Bob and Carol generate a number by themselves respectively.

Secondly, all of them coordinate two values, g and n .

Thirdly, Bob sends Y to Alice. The Y is counted by g, y and n . The equation is shown in (1).

$$Y = g^y \mod n \quad (1)$$

In this function, if the attacker eavesdropped the Y, g and n in the second step, he/she still can not compute the y .

The next three steps like third step. In step 4), Carol sends Z to Alice. The equation Z is shown in Figure 1. In step 5), Alice sends X to Bob. In step 6), Alice sends X' to Carol.

Finally, Alice calculates the value k . Bob calculates the value k' . Carol calculates the value k'' . The equation of k, k' and k'' shown in Figure 1. The result of this mechanism is that all of the values k, k', k'' are identical. Therefore, Alice, Bob and Carol share the same session key.

II. 4 Message Authentication Code (MAC)

Documents which transmit in the public communication and computing environments are very dangerous, especially in the wireless environment. Documents may be hacked easily by anyone. It is very important to check the consistency of the document when a receiver receives this document. The Message Authentication Code is a scheme that can verify the consistency of document. [11] The process of *MAC* is as follows:

Step 1) Initial: Sender and receiver have the same authentication key

Step 2) Sender: $sMAC = MAC$ (original document, authentication Key)

Step 3) Sender \rightarrow receiver: $sMAC +$ document copy

Step 4) Receiver: $rMAC = MAC$ (document copy, authentication key)

If $sMAC = rMAC$ then

Document is correct

Else

Document may be modify and isn't valid document.

End if

In Step 1), both of parties need to obtain and know the same authentication key before communicating with each other.

In step 2), a sender uses an *MAC* algorithm which takes the original document and the authentication key into count to generate a message digest. The *MAC* algorithm often uses a hash algorithm to accomplish.

In step 3), the sender transfers the document copy and the message digest to the receiver.

In step 4), a receiver generates a message digest which is created by *MAC* algorithm by using the received document and his authentication key. Then receiver compares message digest received from sender with the one generated by receiver. If both of them are equal, the document is correct. Otherwise, the document may be modified by hacker. By using *MAC*, we can verify whether document is consistent or not.

III. Proposed Scheme

III.1 Abbreviation

The abbreviations of the relevant data used in following description are shown in Table 1.

TABLE 1. Abbreviations of the data used in the proposed mobile payment scheme

Abbreviation	Description
<i>PG</i>	Payment Gateway – a trusted third part. It is responsible for verifying the accuracy of transaction and transferring accounts
<i>TID</i>	Transaction Identification number
<i>M</i>	Merchant
<i>Ma</i>	Merchant account in the payment gateway
<i>C</i>	Customer
<i>Ca</i>	Customer account in the payment gateway
<i>OI</i>	Order Information
<i>P</i>	Total price of orders
$eK_i\{message\}$	Encrypt the message via the key K_i
$dK_i\{message\}$	Decrypt the message via the key K_i
$MAC\{message, K_i\}$	Run the <i>MAC</i> algorithm. The inputs are message and authentication key K_i
<i>Kcp</i>	Session <u>K</u> ey between <u>c</u> ustomer and <u>p</u> ayment gateway
<i>Kmp</i>	Session <u>K</u> ey between <u>m</u> erchant and <u>p</u> ayment gateway
<i>Kcmp</i>	Session <u>K</u> ey among <u>c</u> ustomer <u>m</u> erchant and <u>p</u> ayment gateway
<i>PIN</i>	Personal Identification Number

III.2 Basic assumption

- The customer's device can access the Internet, e.g. GPRS.
- Customers and merchants have an account at least in the payment gateway. And payment gateway maintains the accounts.
- The transmission is reliable in wireless environment. It means that it will retransmit data if errors occur.

- All of the keys – *Kcp*, *Kmp* and *Kcmp* – are generated by the use of *Diffie-Hellman key exchange* scheme.

- Payment gateway is a public's trusted third party.

- When customers and merchants login the payment gateway, both of them need to input account and password to authenticate.

III.3 Payment process

Our payment scheme idea is that customer and merchant send transaction information separately to the payment gateway. Both of customer and merchant can not get another part's information, because the information is hidden by the use of *MAC* which is a one-way hash function. When the payment gateway successful receives the transaction information from both customer and merchant, it will compare the information whether they are equal or not. If both of them is equivalent, we can say that the data is correct. Then the payment gateway will transfer an account. After accomplishing transfer, the payment gateway will send receipt to them. The process is shown in Figure 2 and the detail is described below:

Step 1) $M \rightarrow C : TID, OI, P$

Step 2) C : confirm the orders

Step 3) C : input *PIN* number on the mobile device

$M \leftrightarrow PG$:

generate *Kmp* (must login payment gateway)

$C \leftrightarrow PG$:

generate *Kcp* (must login payment gateway)

$C \leftrightarrow M \leftrightarrow PG$: generate *Kcmp*

Step 4) $M \rightarrow C : eK_{cmp}\{MAC(Ma, Kmp)\}$

Step 5) $M \rightarrow PG$:

$eK_{cmp}\{eK_{mp}\{Ma\}, TID, OI, P, MAC(Ma, Kmp)\}$

Step 6) $C : uMAC =$

$MAC((TID||OI||P||Ua||MAC(Ma, Kmp)), Kcp)$

$C \rightarrow PG : eK_{cmp}\{eK_{cp}\{Ua\}, uMAC\}$

Step 7) $PG : rMAC =$

$MAC((TID||OI||P||Ua||MAC(Ma, Kmp)), Kcp)$

Compare if $rMAC = uMAC$

In step 1), after a customer shops at a real store or a web store, the merchant will transmit *TID, OI, P* to customer's mobile device. In a real store, it can be accomplished by point-of-sale system. In a web store, it can be done through wireless communication system as *GPRS*.

In step 2), the customer checks the *OI* and *P* shown on the mobile device's screen. If the information is correct, he/she starts payment process and goes to step 3). If not, he/she can cancel the transaction and restart again.

In step 3), the customer inputs a *PIN* number for first authentication. If the *PIN* number is correct, customer, merchant and payment gateway generate the keys – *Kcp*, *Kmp* and *Kcmp* – which are necessary in the payment process. Those keys are generated by the method of the extension of *Diffie-Hellman key exchange* scheme which is discussed in the sections 2.2 and 2.3.

In step 4), the merchant uses the *Kcmp* to encrypt

$MAC(Ma, Kmp)$ and transfers it to the customer. Only merchant, customer and payment gateway know the key, Kmp , and all communication data among merchants, customers and the payment gateway will be encrypted by Kmp . Consequently, the data are protected and under security.

In step 5), the merchant transmits order information, the merchant account which is encrypted by Kmp and $MAC(Ma, Kmp)$ to the payment gateway. The reason to send $eKmp\{Ma\}$ and $MAC(Ma, Kmp)$ is that the payment gateway can verify whether the merchant account is correct or not. Of course, the communications between them are encrypted by the key, Kmp .

In step 6), when the customer receives the data transmitted from the merchant, it generates $uMAC$. The equation of $uMAC$ is shown in (2).

$$uMAC = MAC((TID||OI||P||Ua||MAC(Ma, Kmp)), Kcp) \quad (2)$$

Because of using MAC , the size of the information will shorter than the one without using MAC . For this reason, it suits to transmit it in the wireless environment. Then the customer transmits $uMAC$ and Ua which is encrypted by Kcp to the payment gateway.

In step 7), when the payment gateway receives all information from the customer and the merchant, it first computes the $rMAC$. The equation of $rMAC$ is shown in (3).

$$rMAC = MAC((TID||OI||P||Ua||MAC(Ma, Kmp)), Kcp) \quad (3)$$

After the payment gateway calculates the $rMAC$, it compares with $uMAC$ which receives from customer before. If $rMAC$ is equal to $uMAC$, the payment gateway starts transferring an account.

IV. Analysis of Security

IV. 1. Evaluation from the aspect of security criteria

When we talk about the security of e-commerce, we usually have to achieve the following security criteria of authentication, non-repudiation, integrity, and confidentiality. Because m-commerce is some kind of e-commerce, m-commerce has to achieve these four security elements to evaluate the system.

IV. 1. 1 Authentication

Customers need to key in PIN number on the cell phone, before using the cell phone to pay. Hence it can procure the authentication. In the cell phone is stolen, it can not work without PIN code. In the payment gateway, customers and merchants have to login the system when they want to conduct a transaction. It needs account information and password when they login the payment gateway. Therefore, there are also ID identify in the payment gateway to ensure the security for the system.

IV. 1. 2 Confidentiality

In the proposed scheme, merchants transfer TID , OI , and other related information to customers without encrypting in the first step. While in other transferring steps, all

participants use $Kcmp$ to perform symmetric cryptography. Because there is no account information in the message of the first step, if some information is changed by illegal ways, customers can make sure whether the information is right or not and refuse the requirement. So there is not any influence in the confidentiality of the scheme.

IV. 1. 3 Integrity

When transferring information in the system, all information use MAC to ensure the integrity except for the first step. In first step, the customers check the transaction data shown on the screen of mobile device manually. In others steps, the computer will use MAC to check the integrity automatically. It is easy to use MAC to achieve the integrity. The output of MAC will be different if the input is different. In our scheme, the input data are composed of TID , OI and other related information. Most of them are difference in each transaction. It is hard to find that all input data is equal to old one. Therefore, we can ensure that the MAC can achieve the integrity in the proposed scheme.

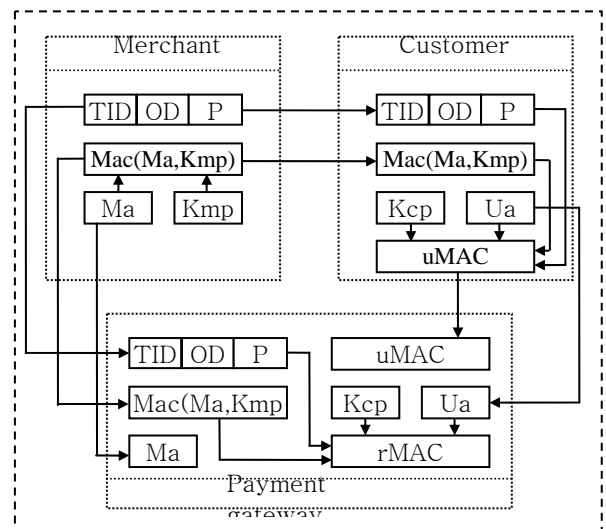


FIGURE 3. Data flow in our payment scheme

IV. 1. 4 Non-repudiation

Before dealing, customers and merchants have to login the payment gateway first and then they can proceed to go through the payment process. Customers and merchants use the Diffie-Hellman key exchange protocol to obtain keys, so that an account has a session key. The payment gateway will record the relationship between accounts and session keys. The system uses the method to achieve non-repudiation. When customers and merchants transfer their account, all of them use their individual session key to encrypt. Before producing the session key, customers and merchants have to login the payment gateway, and payment gateway is a public reliable third party. So based on the reason, the system can reach non-repudiation.

IV. 2 Evaluation from the aspect of attacker's role

In our proposed scheme, we do not evaluate malicious payment gateway, because it is a public trusted third party. In this section, we only evaluate the aspects of malicious merchant, customer and other attackers.

1) Malicious merchant

First, a malicious merchant may fabricate a transaction. This action will make customer lost his money unknowingly. In our scheme, merchant needs customer's account to conduct a transaction. In Figure 3, when conducting a transaction, customer's account information is never transmitted to the merchant. When transmitting the U_a , it is also encrypted by session key " K_{cp} " and " K_{cmp} ". For this reason, it has a very low probability to happen that the U_a is obtained by other one.

Secondly, the merchant will modify the price higher than original one when it transfers price to payment gateway. But the $rMAC$ will not be equal to the $sMAC$ which both of them need price information to generate.

Thirdly, malicious merchant may deny the transaction. In our scheme, transaction records will be recorded by payment gateway when conducting a transaction. As merchant logs in the payment gateway, he needs Ma and password. But both of them are not easy to obtain. All transmissions of the Ma are encrypted by session key " K_{mp} " and " K_{cmp} ". It is very difficult to steal the Ma 's information.

2) Malicious consumer

In the first place, malicious consumer may modify the price lower than original one when it transfers price to payment gateway. Like above section, the $rMAC$ will not be equal to the $sMAC$ when payment gateway compares $rMAC$ with $sMAC$. Then the transaction will be canceled.

In the next place, malicious consumers may deny the transaction. In our scheme, customer will input PIN code in the mobile device first when performing the mobile payment. Transaction records also will be recorded by payment gateway. The information of U_a is encrypted by session key " K_{cp} " and " K_{cmp} ". So it is very difficult to eavesdrop the U_a 's information.

3) Other attacker

All of transmission in our proposed scheme use K_{cmp} to encrypt data. Because we use symmetric cryptography, the time of encryption is short. And each session key only uses one time. If anyone wants to modify transaction data, he must compute the K_{cmp} . But computing the K_{cmp} is not easy. Even though he computes the K_{cmp} , the transaction has already been completed early.

V. Conclusions

With the development of communication network, there are more and more people enjoy the convenience of using mobile device. It does not like the traditional wired environment which is limited to a fixed place. It can be

worked at any time and any where. With smaller size and lighter weight, mobile devices can be a basic platform for many business activities in the future. But mobile device's electricity, memory and computation ability are not as strong as traditional PC, so these factors need to be considered in developing service in mobile devices.

When using asymmetric cryptography, it will consume much time and electricity of the device. In our proposed scheme, we use symmetric cryptography to save electricity and decrease computing time. In the way, we can extend the life time of the device and decrease the waiting time when customers perform the payment process.

In the cryptography, the most importance thing is how to obtain the encryption key. In our payment scheme, we use Diffie-Hellman key exchange scheme to generate all the session keys we need. The process of key generation is simple and does not need complex operation. Hence, the method is appropriate to mobile devices which usually have low computing ability.

In the respect of security, the keys of conduct a transaction are different in each transaction. Therefore, there is useless to steal the keys, because all session keys only use one time. Another reason is that the transaction is accomplished when attackers obtain all session keys, because the time of conduct a transaction is short. If the keys is not easy to obtain, and most of the communication in our scheme is encryption, our scheme is secure.

In the respect of key management, we do not use public key infrastructure (PKI). In our scheme, we use "*Diffie-Hellman key exchange*" to generate session keys. The key management is done by payment gateway. Because there is no usage of PKI , the communication times will reduced. The less the communication times is, the more security the payment scheme is.

As above mention, our payment system offers a secure payment system and fits the characteristics of mobile device.

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Based on MIPv6 with Support to Improve the Mobile Commerce Transaction

Yen-Chu Hung¹, Zhong-Hong Hang¹, Chia-Wei Tsai², Chia-Hung Hong³
¹Andrew@mail.ncyu.edu.tw ²s0930316@mail.ncyu.edu.tw ³chhong@csie.ncyu.edu.tw

Abstract: Mobile Commerce is anticipated to be the next business revolution. Under the trend of mobile age, a person begins to realize the benefits of transaction by mobility operations. We can access information, shop and bank on line, work from home and speak and send messages via mobile appliances throughout all over the world. The research that is mobile transaction managing on database has begun since 1950 and skips the Link and Network Layer with support to improve mobile commerce. This paper focus on how effectually to make the new generation of mobile network protocol apply on mobile commerce and improve the mainly four properties required by mobile transactions. The four properties are respectively atomicity, consistency, isolation and durability. The purpose based on the mobile commerce environment and making mobile transactions complete and personal by means of the Destination Extension Header based on IPv6 and the Java Transaction Service. After experiment and testing, this paper verify that we improve the mobile commerce environment and make the mobile transaction more complete with the optimization of the Destination Extension Header based on IPv6 and the Java Transaction Service under the comparison with the environment on IPv4.

Keywords: IPv6, Destination Extension Header, Java Transaction Service.

I. Introduction

Mobile Commerce, or m-Commerce, is about the of applications and services that are becoming accessible from Internet-enabled mobile devices. It involves new technologies, services and business models. It is quite different from traditional e-Commerce. Mobile commerce is defined as the exchanges or buying and selling of commodities, service, or information on the Internet by using mobile handled devices such as PDA, cellular phone and laptop. It is estimated that 12 hundred million wireless device users in the global village will use their hand-held devices to authorize payment for premium content and physical goods. It is obviously trend that mobile commerce is more and more customary with the population of mobile handed devices. At the turn of the 21st century, the focus of telecommunication changed quickly, from traditional wired telephony-oriented services to data-based services; from homogeneous to heterogeneous networks; from non-intelligent devices to smart handhelds, personal digital assistants and mobile computers [23]. With the imminent

deployment of 3G and the the emergence of 4G mobile networks in the near future, it is expected that a sizable proportion of e-commerce traffic will move to mobile and wireless networks in the near future. To realize this above-mentioned potential, there has been some research in the field of mobile commerce including a three dimensional framework using four levels: applications, user infrastructure, middleware, and network infrastructure. With these advances in mobile commerce, it is expected that there will be an exponential surge in mobile commerce applications. In this paper, introduces the four standard attributes of mobile commerce transactions and identifies the requirements of mobile commerce transactions. More specifically, this thesis makes a sketchy investigation about the QoS requirements of mobile transactions and address how such transactions could be supported when the users of mobile commerce services experience a connectivity problem. As the existing IPv4 networks are not adequate to represent the quality for mobile commerce transactions, this paper makes it better then traditionally transactions management system to utilize the IPv6 packet header. IPv6 has a new way to deal with options that has substantially improved processing. It handles options in additional headers called Extension headers. This paper delves into one of six extension headers and it is called "Destination Option header" and a destination option header carries optional information that is examined by the destination node only. This thesis utilizes the IPv6 extension header and Java Transaction Service to improve four situations:

- All intermediate results must be kept hidden inside of the transaction
- To avoid inconsistencies due to conflicts of concurrent operations
- A transaction which access to some data must not know other transactions which concurrently access to the same data
- The produced output of a transaction must be visible and permanent as soon as the transaction commits.

II. Background

Mobile commerce systems often involve many activities and actors, which may work together to solve a given problem, or completely independent. In most of cases, different kinds of concurrent transactions are involved in complex applications, which require a mechanism for controlling and coordinating complex concurrent activities. Additionally, transaction models have been developed for database systems, ensuring fault tolerance properties in spite of concurrent access to the same data. Techniques have been proposed to deal with faults in complex distributed systems.

Therefore, this paper introduced the basic definition of mobile transaction and the four important properties a transaction must satisfy.

Transactions

Transactions were introduced to ensure the database systems integrity when concurrent programs work on same data. The transaction model is employed to prevent software or hardware failures and concurrent accesses to same data by different activities. Thus, a transaction groups simple operations together to form an indivisible set of operations with respect of concurrent transactions. A transaction must satisfy four properties, known as the ACID properties [18]: Atomicity, Consistency, Isolation, Durability; Classical implementations of a transaction model ensure transaction isolation by a locking mechanism. Data objects are locked if they are manipulated by a transaction, and until the transaction is committed or aborted. To achieve atomicity and consistency, the system orchestrates recovery in case of failure. Recovery is based on ensuring durability of the committed transactions' effects and discarding the effects of transactions that were being executed at the time of the failure and thus will be aborted. Logging is the principal service that is used to support recovery. Additional mechanisms are often used to ensure consistency and durability. In database systems we are interested only in data, whereas in distributed systems a resource is usually data together with related operations, often called a *transactional object*.

Mobile transaction models

Advances in wireless communications technology and portable computing devices have created a new paradigm, called *mobile computing*. Mobile computing is distinguished from classical, fixed-connection computing by the mobility of users and their computers and the mobile resource constraints such as limited wireless bandwidth and limited battery life. The model of a system that supports mobile computing consists of static and mobile components, where the only mobile component is the *Mobile Units*. Static elements are *Fixed Hosts* and *Base Stations*. A fixed host is not capable of connecting to the mobile units, while a base station is capable of connecting with mobile unit and is equipped with a wireless interface. Base stations act as an interface between the mobile computers and fixed hosts. They are also known as *Mobile Support Stations*. The geographical area covered by a base station is called a *cell*. To lessen the difficulty, this paper will represent the conceptual Figure 1 with the global view and it is formal to view not only mobile nodes as mobile units but also GSM as TCS in this framework. The disconnection of mobile stations for possibly long periods of time and bandwidth limitations requires a re-evaluation of transaction model and transaction processing techniques. There have been many proposals to model mobile transactions with different notions of a mobile transaction. Most of these approaches view a mobile transaction as consisting of sub-transactions

which have some flexibility in consistency and commit processing. In many of the models presented in the following sections, relaxing some of the ACID properties and non-blocking execution in the disconnected mobile unit, caching of data before the request, adaptation of commit protocols and recovery issues are examined [18].

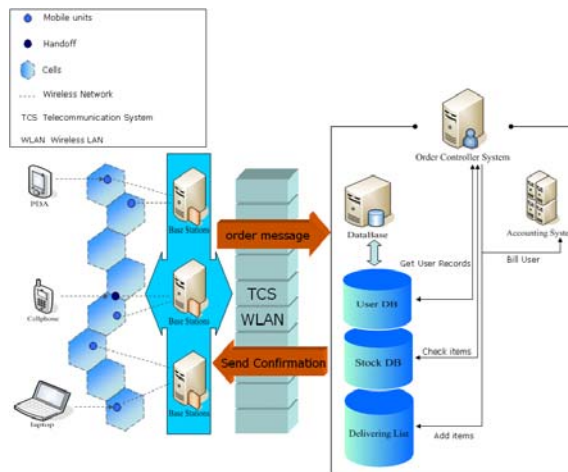


Figure 1: Conceptual Mobile Commerce Environment Framework

Advanced transaction models

a. Reporting and Co-Transactions Model

The Reporting approach [12] proposes an extension to the open-nested transaction model by addressing cell migration issues, in which a mobile transaction is structured as a set of sub-transactions (termed *component transactions*) and this model is shown in the Figure 2. The model is devised for mobile units constantly connected to the network, but moving through different cells. The model supports four types of sub-transactions that are expected to run on both mobile unit and fixed host:

- *Atomic transactions* with the classical ACID properties
- *Non-compensatable transactions* which cannot be compensated and therefore are not permitted committing their effect before its parent commits.
- *Reporting transactions* can report some of their results to other transactions at any point during execution. A report can be considered as a delegation of state between transactions.
- *Co-Transactions* are reporting transactions where control is passed from the reporting transaction to the one that receives the report. Co-transactions are suspended at the time of delegation and they resume their execution when they receive a report.

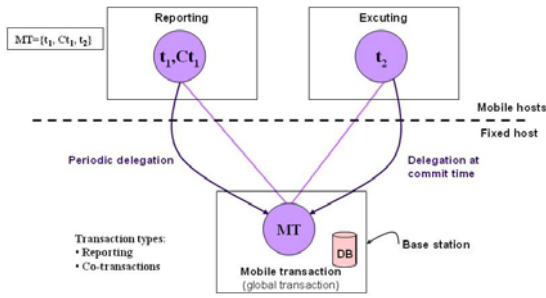


Figure 2: Reporting Model

However, mobile units are assumed to be always connected to the network, so disconnection handling is not considered in this model.

b. Clustering Model

A flexible, two-level consistency model has been introduced in [5] to deal with the frequent, predictable and varying disconnections and this model is shown in the Figure 3. It is also pointed out that, maintaining data consistency over all distributed sites injects unbearable overheads on mobile computing, and a more flexible open nested model is proposed. The model is based on grouping semantically related or closely located data together to form a cluster. Data are stored or cached at a mobile unit to support its autonomous operations during disconnections. A fully distributed environment is assumed where users submit transactions from both mobile and fixed terminals. Transactions may involve both remote data and data stored locally at the user's device. The database is dynamically divided into clusters, and all data items inside a cluster are required to be fully consistent, while replicated data at different clusters may exhibit bounded inconsistencies. A cluster may be distributed on several strongly connected units. When a mobile unit is disconnected it becomes a cluster by itself. Therefore, clusters of data may be explicitly created or merged by a probable disconnection or connection of the associated mobile unit. Also, the movement of the mobile will cause the place of the mobile in the cluster, when it enters a new cell, it can change its cluster too. For every object two copies are maintained, one of them (strict version) must be globally consistent, and the other (weak version) can tolerate some degree of inconsistency but must be locally consistent. Weak transactions access only weak versions whereas strict transactions access strict versions. Weak transactions have two commit points, a local commit in the associated cluster and an implicit global commit after cluster merging. When reconnection is possible (or when application consistency requires it) a synchronization process, executed on the database server, allows the database to be globally consistent. Thus, weak operations support disconnected operation since a mobile device can operate disconnected as long as applications are satisfied with local copies. Users can use weak transactions to update mostly private data and strict transactions to update highly used common data.

Furthermore, by allowing applications to specify their consistency requirements, better bandwidth utilization can be achieved.

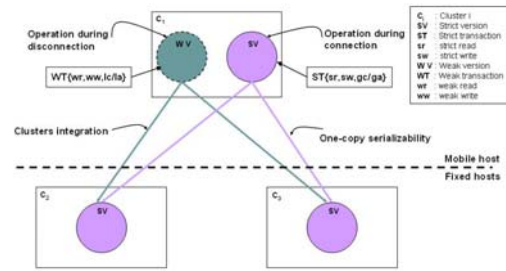


Figure 3: Clustering Model

c. Semantics-based Model

The Semantics-based approach [6] proposes the focus on the use of object semantics information to improve the mobile unit autonomy in disconnected mode. This contribution concentrates on *object fragmentation* as a solution to concurrent operations and to limitations of mobile unit storage capacity. This approach uses objects organization and application semantics to split large and complex data into smaller and manageable fragments of the same type. Each fragment can be cached independently and manipulated asynchronously. Fragment objects can be aggregate items, sets, stacks and queues. This model is shown in the Figure 4.

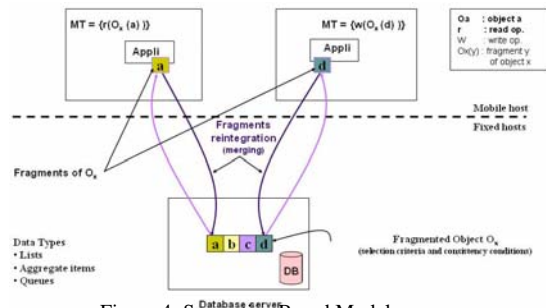


Figure 4: Semantics-Based Model

d. Pro-motion Model

The Pro-Motion approach [7] focuses on ensuring data consistency under disconnections and mobility and this model is shown in the Figure 5. Its fundamental building block is the *compact* which functions as basic unit of replication for caching, prefetching, and hoarding. A compact is an abstraction that encapsulates the caching data, methods for access of the cached data, current state information, consistency rules, obligations and interface methods to allow interaction between compacts and the mobile unit. It represents an agreement between the database server and the mobile host where the database

server delegates control of some data to the mobile unit to be used for local transaction processing. The database server is not aware of what the mobile unit will do with the compact data. It only receives back updates of those data when the computation on the mobile unit is ready to be reported. The mobile unit must comply with the methods and obligations specified in the compact. To improve autonomy and to increase concurrency, object semantics are used in the construction of compacts whenever possible. The main disadvantage is that the original fixed element called Base Station was modified in this proposal. Consequently, this shortcut will obstruct the implementation of the framework based on the mobile IPv4 network.

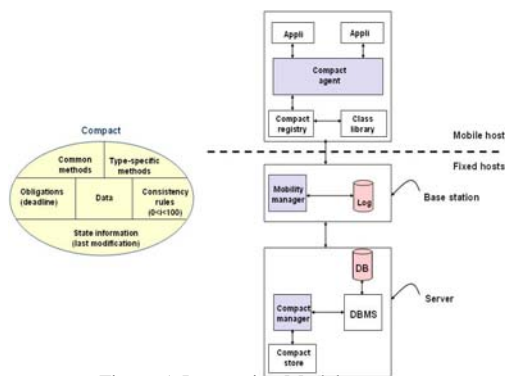


Figure 5: Pro-motion Model

The Communication Protocol Introduction

The success of a session in wireless networks depends on the link quality at the time the session is in progress. A poor quality link is possible to result in the disconnection of mobile commerce session. The disconnection of a session could lead to the termination of any on-going mobile commerce transactions, thus resulting in lots of effects such as loss of opportunities for the users on loss of revenue for the wireless service provider. Although it is not practical that all possible reasons for disconnection can be avoided, it is possible that some transactions could still be completed in such an environment. This paper utilizes the extension header based on IPv6 to construct the mobile environment and adopts the Destination Option Header, one of six Extension headers defined by the current IPv6 specification (RFC2460). Essentially speaking, IPv6 has a new way to deal with options that has substantially improved processing and handles options in additional headers called processing headers. There can be zero, one, or more than one Extension header between the IPv6 header and the upper-layer protocol header. Each Extension header is identified by the Next Header field in the preceding header. The Extension headers are examined or processed only by the node identified in the Destination Address field of the IPv6 header. Consequently, this thesis introduces the basic operation of IPv6 and mobility support of IPv6 and makes some comparisons between IPv4 and IPv6 in the following subsections.

a. Mobile IPv6 Operation

We put the operation procedure of whole Mobile IPv6 sequentially as follows step by step, shown as Figure 6.

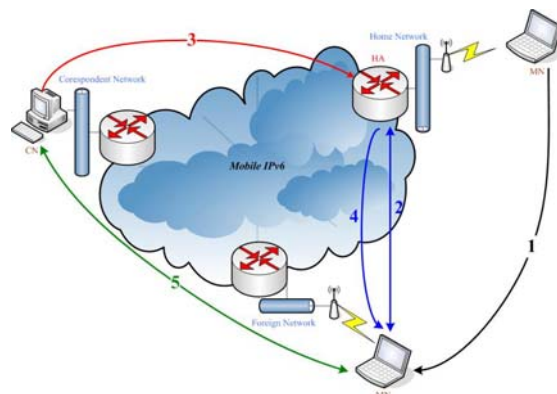


Figure 2.6: Mobile IPv6 Operation Sequentially

1. The MN travels to a foreign network and get a new CoA (Care of Address).
2. The MN performs a binding update to its Home Agent (HA) and the new CoA gets registered at HA. HA sends a binding acknowledgement to MN.
3. A CN wants to contact the MN. The HA intercepts packets destined to the MN.
4. The HA tunnels all packets to the MN from the CN using MN's CoA.

When the MN answers the CN, it may use its current CoA and perform a binding to the CN and communicate with the CN directly (optimized routing) or it can tunnel all its packets through the HA.

b. Mobility Support of IPv6

Mobile IPv6 allows a portable device to be move from one network to another network without changing its IP address and without its exiting connections. Additionally, no need to change its IP address makes it possible for mobile node to act as both client and server. The Mobile IPv6 solution presented here deals with macro-mobility mechanisms at layer3. This solution is the following:

- Keeping alive any communication between a mobile node and a correspondent node while the Mobile Nodes moves from an IP sub-network to another IP sub-networks. This innovative mechanism makes the action of a mobile node be as seamless as possible.
- Allowing a mobile node to be connected with the same IP address wherever the IP sub-networks the Mobile Node is connected to.

c. Compare IPv6 to IPv4

There are many significant differences between IPv6 and IPv4 and this section will examine the most significant difference. The most significant differences are:

- Streamlined Header Format

- Flow Label
- 128-bits Network Address
- Elimination of Header Checksum
- Fragmentation Only by Source Host
- Extension Headers
- Built-in Security

d. Header Comparison

IPv6 provides a more streamlined header than that of IPv4. Five fields are eliminated, including the variable-length IPv4 options field. Removal of the variable length field and other fields permits the IPv6 header to have a fixed format of 40 bytes in length. A comparison of the two types of headers is summarized in Table 1.

Table 1: Header Comparison Between IPv6 and IPv4

	IPv6	IPv4
Header Format	Fixed	Variable
Header Field	8	13
Header Length	40 bytes	20~60 bytes
Address length	128 bits	32 bits
Header Checksum	No	Yes
Fragmentation Fields	No	Yes
Extension Headers	Yes	No

e. Technology Comparison

Although Mobile IPv6 operated in coordination with the usability of IPv6, it was incompatible with Mobile IPv4. This paper delves into the evolution of the mobile network protocol.

1. The designation of Mobile IPv6 was penetrated in the IPv6:
 - a. Mobile IPv6 revoked the necessary existence of Foreign Agent (FA) based on Mobile IPv4 and embedded the original functions of FA in a router.
 - b. Mobile IPv6 revoked the designation of FA's CoA in order to support only the co-located CoA., because it considered the importance of End to End Security.
2. The utilization that transmitting packets as often as delivering Mobile IP messages improved the proceeding rate.
3. Mobile IPv6 was simplifying the mobile IP messages.
4. The route optimization and the smooth handover were the necessary support of mobile network based on Mobile IPv6.

III. Method

From the of Pro-Motion Model, this thesis recognized that what possible approaches this research can simulate and what possible disadvantages this research can modified. In

the section 「Usability Challenges of Mobile Services」, this thesis listed the crucial usability challenges of mobile services and the major issues about the mobile services based on Mobile IPv4 network. In the section 「Mobile Commerce Transaction Based on Mobile IPv6」, this thesis constructs the Mobile Commerce Transaction based on Mobile IPv6 and represents the Java Transaction Service Object (JTSO) in the Waterfall view. Finally this thesis proposes the Client-Server algorithm which ensures the Destination Option header to guarantee the connection End to End.

Usability Challenges of Mobile Services

When services are offered and transactions are operating via wireless connection to mobile users using handheld devices. Additionally, mobile user moved from Home Network to Foreign Network, crucial usability issues are [18]:

- How to facilitate the use of heterogeneous services
- How to adapt service interaction and display of content to the limitations of handheld devices, especially use the small displays.
- How to keep users' expenses for the wireless connection and use of services low and adequate to what they finally get
- How to deal with changing technical environments (e.g. changing quality of services for the underlying network connections)
- How to enhance the trust that users feels towards their service providers and how to protect user privacy

Most of mobile commerce system based on Mobile IPv4 network had not only lots of usability challenges but also many the basic layer problems. Via the Figure.7, this paper listed some major issues, the following are:

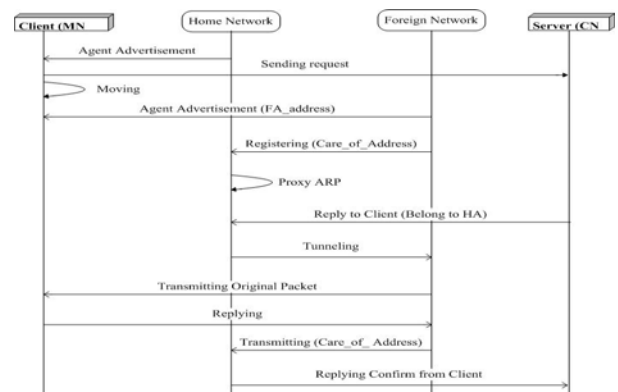


Figure 7: Mobile IPv4 Operation

- The existence of Foreign Agent made mobile commerce transaction time-consuming and risk-doubling.
- Most of Mobile IPv4 messages were complicated and especially in the Foreign Network.
- The mobile commerce environment based on Mobile IPv4 could not guarantee the connection End to End.

- The Mobile IPv4 was the lake of security and the disconnection would make the content of transactions stolen.
- The address space of Mobile IPv4 is running out.

Mobile Commerce Transaction Based on Mobile IPv6

This thesis proposes the sketch framework shown in the figure 8 and this framework is modified from the Pro-Motion model and constructed in the Mobile IPv6 network. In this framework, the Base Stations were moved out and the Java Transaction Service Object (JTSO) is abstraction that encapsulates the caching data and interface methods to allow interaction between JTSO and the mobile unit to fit the ACID properties. The mainly consideration about ACID is the following in the general view:

- Atomicity: Mainly actions/operations of mobile user
- Consistency: Mainly encapsulating transaction declaration of system
- Isolation: Mainly privacy mechanism and trusted system necessarily
- Durability: Mainly protecting mechanism of system

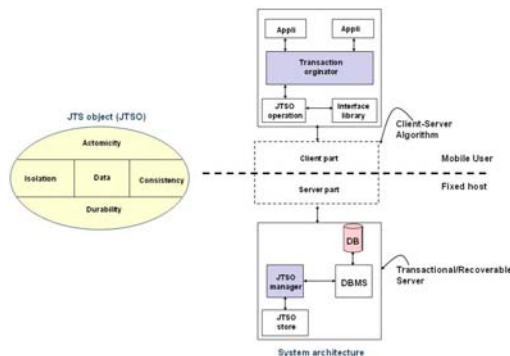


Figure 8: JTS Based on IPv6

In the Waterfall model, it is famous to make software in the process that is requirement, analyzing, designing and testing. To introduce the JTSO clearly, this thesis make the literal combination requirement & general view, analyzing & normalizing view and designing & engineering view.

Java Transaction Service System

The JTS provide an innovative mechanism across the elements of a client/server implementation. Furthermore, the external user will be added in the JTS and the analyzing model about the JTS is in the normalizing view. A transaction can involve multiple objects performing multiple requests. The scope of a transaction is defined by a transaction context that is shared by the participating objects. The JTS places no constraints on the number of objects involved, the topology of the application, or the way in which the application is distributed across a network. In the Figure 9, a client first begins a transaction (by issuing a request to an object defined by the JTS), which establishes a transaction context associated with the client. The client then issues requests. These requests are implicitly associated

with the client's transaction; they share the client's transaction context. Eventually, the client decides to end the transaction (by issuing another request). If there were no failures, the changes produced as a consequence of the client's requests would then be committed; otherwise, the changes would be rolled back. The JTS also supports scenarios where the client directly controls the propagation of the transaction context. For example, a client can pass the transaction context to an object as an explicit parameter in a request. An implementation of the JTS might limit the client's ability to explicitly propagate the transaction context in order to guarantee transaction integrity. The implementation supported by the JTS consists of the following entities:

- Transactional Client (TC)

A transactional client is an arbitrary program that can invoke operations of many transactional objects in a single transaction. The program that begins a transaction is called the transaction originator.

- Transactional Object (TO)

This paper shows the term transactional object to refer to an object whose behavior is affected by being invoked within the scope of a transaction. A transactional object typically contains or indirectly refers to persistent data that can be modified by requests. The Transaction Service does not require that all requests have transactional behavior, even when issued within the scope of a transaction. An object can choose to not support transactional behavior, or to support transactional behavior for some requests but not others. This paper uses the term non-transactional object to refer to an object none of whose operations are affected by being invoked within the scope of a transaction. If an object does not support transactional behavior for a request, then the changes produced by the request might not survive a failure and the changes will not be undone if the transaction associated with the request is rolled back. An object can also choose to support transactional behavior for some requests but not others. This choice can be exercised by both the client and the server of the request.

- Recoverable Object (RO) & Resource

To implement transactional behavior, an object must participate in a certain protocol defined by JTS Service and the protocol is MIPv6. The protocol is used to ensure that all participants in the transaction agree on the outcome (commit or rollback) and to recover from failures. To be more precise, an object is required to participate in this protocol only if it directly manages data whose state is subject to change within a transaction. An object whose data is affected by committing or rolling back a transaction is called a recoverable object. A recoverable object is by definition a transactional object. However, an object can be transactional but not recoverable by implementing its state using some other (recoverable) object. A client is concerned only that an object is transactional; a client cannot tell

whether a transactional object is or is not a recoverable object. A recoverable object must participate in the protocol provided by JTS. It does so by registering an object called a Resource with the JTS. JTS drives the commit protocol by issuing requests to the resources registered for a transaction. A recoverable object typically involves itself in a transaction because it is required to retain in stable storage certain information at critical times in its processing. When a recoverable object restarts after a failure, it participates in a recovery protocol based on the contents (or lack of contents) of its stable storage. A transaction can be used to coordinate non-durable activities not to require permanent changes to storage.

● Transactional/Recoverable Servers

On the one hand, this server is a collection of one or more objects whose behaviors are affected by the transaction, but have no recoverable states of their own. Instead, it implements transactional changes using other recoverable objects. This server when retaining a transactional object does not participate in the completion of the transaction, but it can force the transaction to be rolled back. On the other hand, this server when retaining recoverable objects is a collection of objects.

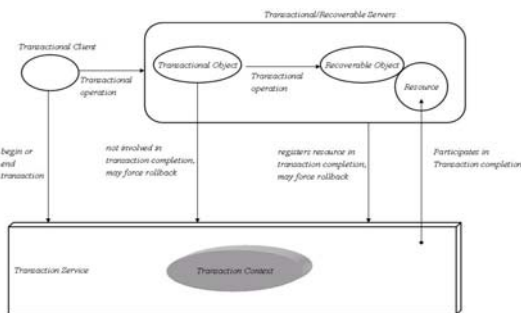


Figure 9: Java Transaction Service

Java Transaction Service System Architecture

Figure 10 illustrates the major components and interfaces defined by the JTS and Figure 11 illustrates the interfaces and methods operated by the JTS to satisfy the ACID properties.

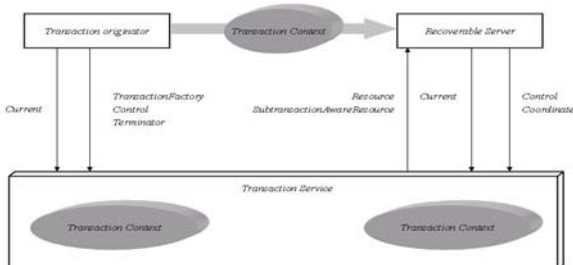


Figure 10: Major Components and Interface of the JTS

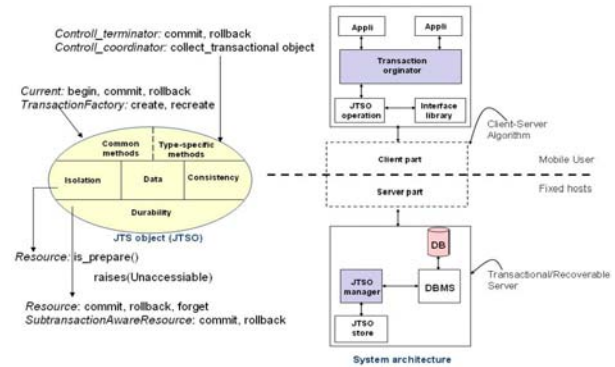


Figure 11: Engineering JTS Based on IPv6

The transaction originator is an arbitrary program that begins a transaction. The recoverable server implements an object with recoverable state that is invoked within the scope of the transaction, either directly by the transaction originator or indirectly through one or more transactional objects. The transaction originator creates a transaction using a *TransactionFactory*; a *Control* is returned that provides access to a *Terminator* and a *Coordinator*. The transaction originator uses the *Terminator* to commit or rollback the transaction. The *Coordinator* is made available to recoverable servers, either explicitly or implicitly. A recoverable server registers a *Resource* with the *Coordinator*. The *Resource* implements the two-phase commit protocol which is driven by the JTS. A recoverable server can register a specialized resource called a *Subtransaction Aware Resource* to track the completion of subtransactions. The interfaces for JTS are as follows:

● Current Interface

The **Current** interface defines operations that allow a client of the JTS to explicitly manage the association between transactions on the connection. The **Current** interface also defines operations that simplify the use of the JTS for most applications. These operations can be used to begin and end transactions and to obtain information about the current transaction. The **Current** interface is a locality-constrained interface whose behavior depends upon and may alter the transaction context.

```
interface Current {
    void begin()

    raises(SubtransactionsUnavailable);
    void commit()
    raises(NoTransaction);
    void rollback()
    raises(NoPermission)
    Status get_status();
    string get_transaction_name();
    void set_timeout(in unsigned long seconds)
    unsigned long get_timeout();
};
```

➤ begin

A new transaction is created. The transaction context of the

client is modified so that the original transaction is associated with the new transaction. If the client is currently associated with a transaction, the new transaction is a subtransaction of the original transaction. Otherwise, the new transaction is a top-level transaction.

➤ **commit**

If there is no transaction associated with the client, the `NoTransaction` exception is raised. Otherwise, the transaction associated with the client is completed.

➤ **rollback**

If the client does not have permission to rollback the transaction, the `NO_PERMISSION` exception is raised. Otherwise, the transaction associated with the client is rolled back.

➤ **get_status**

This operation returns the status of the transaction associated with the client.

➤ **get_transaction_name**

If there is no transaction associated with the client thread, an empty string is returned. Otherwise, this operation returns a printable string describing the transaction.

➤ **set_timeout**

This operation modifies a state variable associated with the target object and the target object affects the time-out period in number of seconds. Besides, this period is associated with top-level transactions. If the parameter has a non-zero value *n*, then top-level transactions will be subject to being rolled back if they do not complete before *n* seconds after their creation. If the parameter is zero, then no application specified time-out is established.

➤ **get_timeout**

This operation returns the state variable associated with the target object that affects the time-out period in number of seconds associated with top-level transactions created by the `begin` operation.

● **TransactionFactory interface**

The **TransactionFactory** interface is provided to allow the transaction originator to begin a transaction. This interface defines two operations, **create** and **recreate**, which create a new representation of a top-level transaction.

```
interface TransactionFactory {
    Control create(in unsigned long time_out);
    Control recreate(in PropagationContext ctx);
};
```

➤ **create**

A new top-level transaction is created and a **Control** object is returned. The **Control** object can be used to manage or to control participation in the new transaction. An implementation of the JTS may restrict the ability for the **Control** object to be transmitted to or used in other

execution environments. At a minimum, it can be used by the client thread. If the parameter has a nonzero value *n*, then the new transaction will be subject to being rolled back if it does not complete before *n* seconds have elapsed. If the parameter is zero, then no application specified time-out is established.

➤ **recreate**

A new representation is created for an existing transaction defined by the **PropagationContext** and a **Control** object is returned. The **Control** object can be used to manage or to control participation in the transaction. An implementation of JTS, which supports inter-position uses **recreate** to create a new representation of the transaction being imported, subordinate to the representation in **ctx**. The **recreate** operation can also be used to import a transaction that originated outside of the JTS.

● **Control interface**

The **Control** interface allows a program to explicitly manage or propagate a transaction context. An object supporting the **Control** interface is implicitly associated with one specific transaction.

```
interface Control {
    Terminator get_terminator()
    raises(Unavailable);
    Coordinator get_coordinator()
    raises(Unavailable);
};
```

The **Control** interface defines two operations, **get_terminator** and **get_coordinator**. The **get_terminator** operation returns a **Terminator** object, which supports operations to end the transaction. The **get_coordinator** operation returns a **Coordinator** object, which supports operations needed by resources to participate in the transaction. The two objects support operations that are typically performed by different parties. Providing two objects allow each set of operations to be made available only to the parties that require those operations. A **Control** object for a transaction is obtained using the operations defined by the **TransactionFactory** interface or the **create_subtransaction** operation defined by the **Coordinator** interface.

● **Terminator interface**

The **Terminator** interface supports operations to commit or rollback a transaction. Typically, these operations are used by the transaction originator.

```
interface Terminator {
    void commit(in boolean report);
    void rollback();
};
```

➤ **commit**

If the transaction has not been marked rollback only, and all of the participants in the transaction agree to commit, the transaction is committed and the operation terminates normally. Otherwise, the transaction is rolled back. The **report** parameter allows the application to control how long

it will block after issuing a commit. If the **report** parameter is true, the call will block until the commit protocol is complete and all outcomes are known. The JTS will report inconsistent or possibly inconsistent outcomes. If the parameter is false, the implementations of the JTS may make use of this fact to block only. When a top-level transaction is committed, all changes to recoverable objects made in the scope of this transaction are made permanent and visible to other transactions or clients. When a subtransaction is committed, the changes are made visible to other related transactions as appropriate to the degree of isolation enforced by the resources.

➤ **rollback**

The transaction is rolled back. When a transaction is rolled back, all changes to recoverable objects made in the scope of this transaction (including changes made by descendant transactions) are rolled back. All resources locked by the transaction are made available to other transactions as appropriate to the degree of isolation enforced by the resources.

● **Coordinator interface**

The **Coordinator** interface provides operations that are used by participants in a transaction. These participants are typically recoverable objects. Each object supporting the **Coordinator** interface is implicitly associated with a single transaction.

```
interface Coordinator {
    Status get_status();
    Status get_parent_status();
    Status get_top_level_status();
    boolean is_same_transaction(in Coordinator tc);
    boolean is_related_transaction(in Coordinator tc);
    boolean is_ancestor_transaction(in Coordinator tc);
    boolean is_descendant_transaction(in Coordinator tc);
    boolean is_top_level_transaction();
};
```

➤ **get_status**

This operation returns the status of the transaction associated with the target object: `Status_Active`, `Status_Prepate`, `Status_Commit`, `Status_RolledBack`, `Status_Unknown` and `Status_NoTransaction`.

➤ **get_parent_status**

If the transaction associated with the target object is a top-level transaction, then this operation is equivalent to the **get_status** operation. Otherwise, this operation returns the status of the parent of the transaction associated with the target object.

➤ **get_top_level_status**

This operation returns the status of the top-level ancestor of the transaction associated with the target object. If the transaction is a top-level transaction, then this operation is

equivalent to the **get_status** operation.

➤ **is_same_transaction**

This operation returns true if and only if the target object and the parameter object both refer to the same transaction.

➤ **is_related_transaction**

This operation returns true if and only if the transaction associated with the target object is related to the transaction associated with the parameter object. A transaction T_1 is related to a transaction T_2 if and only if there is a transaction T_3 such that T_3 is an ancestor of T_1 and T_3 is an ancestor of T_2 .

➤ **is_ancestor_transaction**

This operation returns true if and only if the transaction associated with the target object is an ancestor of the transaction associated with the parameter object. A transaction T_1 is an ancestor of a transaction T_2 if and only if T_1 is the same as T_2 or T_1 is an ancestor of the parent of T_2 .

➤ **is_descendant_transaction**

This operation returns true if and only if the transaction associated with the target object is a descendant of the transaction associated with the parameter object. A transaction T_1 is a descendant of a transaction T_2 if and only if T_2 is an ancestor of T_1 .

➤ **is_top_level_transaction**

This operation returns true if and only if the transaction associated with the target object is a top-level transaction. A transaction is a top-level transaction if it has no parent.

● **Resource interface**

The **Resource** interface defines the operations invoked by the transaction service on each resource. Each object supporting the **Resource** interface is implicitly associated with a single top-level transaction. Note that in the case of failure, the completion sequence will continue after the failure is repaired. A resource should be prepared to receive duplicate requests for the **commit** or **rollback** operation and to respond consistently.

```
interface Resource {
    is_prepare();
    raises(Unaccessible);
    void rollback();
    void commit();
    void forget();
};
```

➤ **is_prepare**

If no persistent data associated with the resource has been modified by the transaction, the resource can return read only or not. After receiving this response, the JTS is not required to perform any additional operations on this resource. Furthermore, the resource can forget all knowledge of the transaction. If the resource is able to write (or has

already written) all the data needed to commit the transaction to stable storage, as well as an indication that it has prepared the transaction, it can call **commit**. After call the **commit**, the JTS is required to eventually perform either the **commit** or the **rollback** operation on this object.

➤ **rollback**

If necessary, the resource should rollback all changes made as part of the transaction. If the resource has forgotten the transaction, it should do nothing.

➤ **commit**

If necessary, the resource should commit all changes made as part of the transaction. If the resource has forgotten the transaction, it should do nothing.

➤ **forget**

This operation is performed only if the resource raised the exception to **rollback**, **commit**, or **prepare**. Once the coordinator has determined that the situation of the transaction's resource has been addressed, it should issue **forget** on the resource. The resource can forget all knowledge of the transaction.

● **Subtransaction Aware Resource interface**

Recoverable objects that implement nested transaction behavior may support a specialization of the **Resource** interface called the **SubtransactionAwareResource** interface. A recoverable object can be notified of the completion of a subtransaction by registering a specialized resource object that offers this interface with the JTS. The JTS uses this interface on each **Resource** object registered with a subtransaction. Each object supporting this interface is implicitly associated with a single subtransaction.

```
interface SubtransactionAwareResource : Resource
{
    void commit_subtransaction(in Coordinator parent);
    void rollback_subtransaction();
};
```

➤ **commit_subtransaction**

This operation is invoked only if the resource has been registered with a subtransaction and the subtransaction has been committed. The **Resource** object is provided with a **Coordinator** that represents the parent transaction. Note that the results of a committed subtransaction are relative to the completion of its ancestor transactions, that is, these results can be undone if any ancestor transaction is rolled back.

➤ **rollback_subtransaction**

This operation is invoked only if the resource has been registered with a subtransaction and notifies the resource that the subtransaction has rolled back.

The Destination Options Header Based on Mobile IPv6

This paper adopts the quotation about the header structure of

an IPv6 packet specified in RFC2460 in order to make a transaction complete possibly [1]. A Destination Options header carries optional information that is examined by the destination node only. The Next Header value identifying this type of header is the value 60. Figure11 shows the format of the Destination Option header.



Figure 11: Format of the Destination Options header

The following list describes each field:

● *Next Header*

The Next Header field identifies the type of header that follows the Destination Options header.

● *Header Extension Length*

This field identifies the length of the Destination Options header in 8 byte units. The length calculation does not include the first 8 bytes.

● *Options*

There can be one or more options and the length of the options is variable and determined in the Header Extension Length field.

The utilization of Destination Option header to construct mobile commerce

Before the basic construction based on Mobile IPv6, this research makes some considerations listed in the following issues:

How well do it make each component of mobile network perform under realistic conditions to utilize the Destination Option header

How well should this research perform both before and after a new application is extended or a new priority scheme is introduced in the proposed methods listed in the background.

Is the highest priority of a transaction maximum throughput, or minimal response time for each type of network transaction

According the above considerations, this paper proposes the Client-Server algorithm that not only utilizes the Destination Option header to guarantee the connection End to End but also sets Time variable and parameter to measure both before and after a transaction. This algorithm is listed in Figure 12 and the description of variable value in this algorithm is listed in Table 2.

Client-Server Algorithm	
Server (Correspondent Node)	Client (Mobile Node)
SLEEP	
initial_delay = 0	
CONNECT_INITIATE	CONNECT_ACCEPT
source_NextHeaderField = 60	destination_NextHeaderField = 60
LOOP	LOOP
number_of_timing_records = 100	number_of_timing_records = 100
START TIMER	
LOOP	LOOP
transactions_per_record = 1	transactions_per_record = 1
SEND	RECEIVE
file_size = 999999	file_size = 999999
send_buffer_size = DEFAULT	receive_buffer_size = DEFAULT
send_data_type = NOPRESS	
send_data_rate = UNLIMITED	
COMFIRM_REQUEST	COMFIRM_ACKNOWLEDGEMENT
INCREMENT_TRANSACTION	
END LOOP	END LOOP
END TIMER	
SLEEP	
transaction_delay = 0	
END LOOP	END LOOP
DISCONNECT	DISCONNECT
close_type = Reset	close_type = Reset

Figure 12: Client-Server Algorithm

Variable Name	Value	Description
initial_delay	0	Pause before the first transaction
number_of_timing_records	100	How many timing records to generate
transactions_per_record	1	Transactions per timing record
file_size	999999	How many byte in the transferred file
send_buffer_size	DEFAULT	How many of data in each SEND
receive_buffer_size	DEFAULT	How many of data in each RECEIVE
transaction_delay	0	Miliseconds to pause
send_data_type	NOPRESS	What type of data to send
send_data_rate	UNLIMITED	How fast to send data
destination_NextHeaderField	60	What option to use for MN
close_type	Reset	How connections are terminated
source_NextHeaderField	60	What option to use for CN

Table 2: Variable value description

IV. Conclusion and Future Work

As this thesis mentioned above, Mobile commerce will become the major tendency toward electronic business because of the benefits such convenience and instantaneous, etc. We also find the government is rapidly moving toward adopting the new Internet Protocol called "IPv6" to provide a standard mobile infrastructure for loosely-coupled large-scale distributed systems. Our thesis has suffered characteristics make developing efficient and effective scheduling algorithm for wireless mobile networks very challenging. The JTS has satisfied the following ACID characteristics that are first a transaction is atomic; if interrupted by failure, all effects are undone, second a transaction produces consistent results; the effects of a transaction preserve invariant properties, third a transaction is isolated; its intermediate states are not visible to other transactions and forth a transaction is durable; the effects of a completed transaction are persistent.

Recognizing that there are still many significant technical challenges exist in the development, deployment and management of such Java Transaction Service mobile commerce applications. The biggest challenge for such a service is the fragmentation of the security requirements. However, their standardized definitions are still evolving and we don't go deep into this issue too much. On the other hand, another future work is to increase data availability and reduce the load on a server by balancing the service access among the replicated transaction servers.

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Exploring Customer Preferences on Mobile Services

Seung Baek, Jinwoo Kang & Woosuk Hong
College of Business Administration
Hanyang University, Seoul, Korea
¹⁾ e-mail: sbaek@hanyang.ac.kr
Tel: 82-2-2220-1062

Abstract: Designing mobile services is fundamentally different than designing online services. Not only are there differences in underlying technologies, but also in the way people use services. If these differences are not taken into account, mobile services are likely to fail. If mobile services do not deliver what people want, these services will fail no matter how excellent the underlying technology is. The user interface design that is commonly used in mobile services is based on multi-layered approach, which is not very user friendly. So a well designed single layered user interface will be more user friendly than the conventional one and it will be having edge over others. However, it is quite difficult to provide a single layered user interface in a small screen. This study aims at examining how user interface design attributes of mobile services affect customer preferences. In order to explore customer preferences to each design attribute, we measure customer's WTP (Willingness To Pay) toward different interface designs.

I. Introduction

In Korea, the phenomenal growth of ownership of cellular phones was not a government initiative, rather a private industry-driven one. As the user population of the high-speed Internet service is growing quickly in Korea, many users are more inclined to use the Internet for multimedia entertainment. With the rapid increase of the internet usage, the growing penetration of wireless devices, and the rapid technological innovation, wireless technology shifts the world of wired Internet to the wireless mobile Internet.

The Internet has provided an easy and effective way of delivering information and services to millions of users who are connected to a wired network. Evidently, this wired network addresses two major constraints: time and place. These limitations have raised the issue of the mobile internet, which enables users to access information from any place at any time. The mobile Internet is expected to deliver great time and place flexibility to individuals.

This study aims at examining how user interface design attributes of mobile services affect customer preferences. In order to explore customer preferences to each design attribute, we measure customer's WTP (Willingness To Pay) toward different interface designs.

II. User Interfaces of Mobile Services

The user interface and the size of mobile devices are the main concerns in design of mobile services. With the advancement in semiconductor technology, the size of mobile devices has reduced a lot. We can actually reduce it further by making a touch screen based user interface because it will avoid the need of physical keypad that takes a lot of space. The other important concern in the design of mobile devices is the User Interface (UI) because it is the one with which users have to interact all the time. The user interface design that is commonly used in mobile services is based on multi-layered approach, which is not very user friendly. So a well designed single layered user interface will be more user friendly than the conventional one and it will be having edge over others. However, it is quite difficult to provide a single layered user interface in a small screen.

III. WTP (Willingness to Pay)

To measure WTP, there are two methods: contingent method and conjoint method. In the contingent method, arbitrary goods or service are presented with specific prices, and then respondents take or reject the offers. While the contingent method asks respondents to evaluate real products, the conjoint method asks them to evaluate hypothetical products. The conjoint method allows researchers to presents respondents with a choice set that contains several alternatives that vary along several attributes, including price. Respondents decide the rankings among the alternatives. Based on the rankings, researchers can analyze the preferences and utilities of respondents for specific goods/service. The major objective of this study is to examine impacts of rich interaction design features of mobile services on customer preferences. To investigate customer preferences, it collects respondents' WTP to specific interface designs of mobile services. To analyze the WTP data, it uses the conjoint method.

IV. Research Methodology

The main purpose of this study is to explore the effects of design attributes of mobile services on WTP. In order to analyze relative impacts of interface design attributes on customers' preferences, this study employs conjoint analysis. A conjoint analysis is one of the most widely-used

methods which are designed to analyze consumer needs. This method shows relative importance of various utilities considered by consumers when they purchase service and a service that consists of the most ideal combination of those utilities. Conjoint analysis originates from mathematical psychology. Conjoint analysis is used to understand how consumers develop preferences for products or services, which encompass, as usual, multi-attributes and multi-attribute levels. Utility is a consumer's subjective measurement of preference that is evaluated for each level of attributes. The utility values associated with each level of attributes are summed as the overall utility. Then, products or services with higher utility are assumed to be of a better choice for consumers. In order to apply the conjoint analysis into this research, we go through the following steps.

Step 1: Specifying Factors and Levels

Based on expert interview, we find that the interface design of mobile service is very critical to attract mobile customers. Wireless Application Protocol (WAP) phones are a growing relevant part of mobile services. In order to use WAP based services, users explore a menu hierarchy. The positions of specific mobile services within menu and the amount of their information within menu affect customer purchase decisions. Table 1 shows different levels of menu design attributes of mobile service. In this study, we examine how the menu design attributes affect customer's WTP.

Table 1. Design Attributes of Menu Design in Mobile Services

Menu Design Attributes	Levels
Mobile service type shown in menu	Entertainment Service Information / Communication Service No Information about Mobile Service Type
Payment information of mobile service shown in menu	Cash Discount Information shown in menu Coupon Information shown in menu No Information about payment shown in menu
Menu position of mobile service	First Line Second Line Middle Line
Recommendation information about mobile services shown in menu	Log Data Based Recommendation User Evaluation Based Recommendation No Information

Step 2: Choosing a Presentation Method

Since this study has four attributes with three levels each, all possible hypothetical products are 81 ($3 \times 3 \times 3 \times 3$). If we use a full-profile method, respondents would have difficulty in answering all 81 questions. For this reason, the number of questions is needed to be diminished to a proper level. As an alternative to a factorial design, we use a fractional factorial design. This approach is a way to reduce the number of questions. The number of initial questions (81 questions) is reduced to 9 questions (refer to Table 2). Based on the fractional factorial design, 9 hypothetical products are generated.

Table 2. Hypothetical Products

Product	Mobile Service Type	Payment Information	Menu Position of Mobile Service	Recommendation Information About Mobile Service
P1	No Information	No Information	First Line	User Evaluation Based Recommendation
P2	Entertainment	Coupon	Middle Line	User Evaluation Based Recommendation
P3	No Information	Cash Discount	Middle Line	No Information
P4	Information / Communication	Cash Discount	Second Line	User Evaluation Based Recommendation
P5	Information / Communication	No Information	Middle Line	Log Data Based Recommendation
P6	Entertainment	Cash Discount	First Line	Log Data Based Recommendation
P7	Entertainment	No Information	Second Line	No Information
P8	Information / Communication	Coupon	First Line	No Information
P9	No information	Coupon	Second Line	Log Data Based Recommendation

Step 3: Selecting a Measure of Consumer Preference

Based on 9 hypothetical products, we design a menu screen. In order to measure customer preferences to specific hypothetical products, the study employs the rank-order method, rather than the rating method. Respondents are asked to provide the maximum monetary amounts that they would pay to get these products. Based on the amounts, we investigate how much each menu design attribute of mobile services affects customer's WTP.

Table 3. Part-Worths and Relative Importance

Attribute	Part-Worth			Relative Importance (%)
	1	2	3	
Mobile Service Type	Entertainment	Information / Communication	No Information	27.51
	1.74	0.32	0.94	
Payment Information of Mobile Services	Discount	Coupon	No Information	26.53
	1.54	0.96	0.50	
Menu Position of Mobile Services	First Line	Second Line	Middle Line	23.21
	1.20	0.48	1.33	
Recommendation Information of Mobile Services	Log Data Based Recommendation	User Evaluation Based Recommendation	No Information	22.75
	0.85	1.16	0.99	

V. Data Analysis

We interviewed 150 respondents, consisting of 86 males and 64 females. Since most of wireless internet users are

younger, most of respondents consist of 12-19 year olds in this study. In addition to portraying the impact of each level (entertainment, information/ communication, no information et. al) with the part-worth estimates, conjoint analysis can assess the relative importance of each design factor (information about mobile service type, payment information of mobile service, position of mobile service, and recommendation information about mobile service). Since the part-worth estimates are on a common scale, the greatest contribution to overall utility of preference, and hence the most important factor, is the factor with the highest range of part-worths.

In this study, we examine the relative impacts of menu design attributes of mobile services on customer's WTP. We try to find an optimal menu design of mobile services that high-valued by users. Table 3 reports the means of the part-worths and relative importance for 150 subjects. The greater the relative importance, the more an attribute influences your preferences for mobile services. If the information about mobile service types is shown in menu, there is the highest possibility that customers purchase mobile services (27.51%). In other words, customers utilize information about mobile service types as critical information in purchasing of mobile services. The second influential menu design attribute is the payment information

of mobile services shown in menu, (26.53%), the third is the positions of mobile services within menu (23.21%), and the last is the recommendation information of mobile service.

VI. Conclusions

One often meets the argument that due to the complexity of the service model and the convergence of technologies and services expected in mobile services, it is very little relevant research available to help us understand the mobile services and their users. The main purpose of the study is to explore attributes that influence customers' preferences to mobile services. To explore the relative importance of the attributes, the study uses conjoint analysis. It finds that the most influential attribute is the mobile service types. This finding supports the current phenomenon that the main usage of mobile services is concentrated on entertainment services. Although this study tries to understand customers of mobile services empirically, it has very limited contributions to theoretical development. In addition, regarding to the relationships between attributes of mobile services and customers' preferences, it does not propose a theoretical explanation.

Enterprise Resource Planning and IT Governance in Perspective: Strategic Planning and Alignment, Value Delivery, and Controlling

Edward W.N. BERNROIDER

Institute for Information Business, Vienna University of Economics and B.A., Austria, Email: bernroider@wu-wien.ac.at

Alexander HAMPEL

Department of Computer Science and Business Informatics, University of Vienna, Email: alexander.hampel@univie.ac.at

Abstract: This article assesses key aspects of IT governance comprising strategic planning especially alignment, value delivery, and control objectives through an empirical study of Austrian medium sized and large enterprises. Enterprise Resource Planning (ERP) systems are in general seen as key information systems supporting e-business processes. The findings show an underdeveloped IT governance competence in the Austrian market place in particular reflected through low levels of strategic alignment and strategic decision making, as well as missing ERP control procedures. Nevertheless, in term of value delivery a positive impact of ERP in a holistic, multi-dimensional assessment was observed covering ERP benefits, organisational performance effects, and key performance criteria used in an ERP balanced scorecard (BSC).

Keywords: Business Infrastructure Management, IT Governance, Enterprise Resource Planning, IT Controlling.

I. Introduction

Today's (e-)business requirements, in particular in terms of enhanced liability and accountability demands, have moved IT governance into the focus of attention. The core processes underlying effective and comprehensive IT governance are the same as those for enterprise governance [6]. IT activities have become critically important to all aspects of the enterprise. This in particular applies to enterprise resource planning (ERP) systems which are in general seen as key information systems supporting e-business processes. ERP is a fine expression of the inseparability of IT and business. As an enabling key technology as well as an effective managerial tool, ERP systems allow companies to integrate at all levels and utilise important extensions, in particular in terms of e-business functionality. They represent large, complex, computerised and integrated systems, which can strongly influence long-term business success. Although e-business is rapidly changing the basic paradigm under which businesses operate, the full potential of e-business can only be realized if e-business technologies (Internet, Intranet and WWW technologies) can be successfully integrated with backbone ERP systems. A review of the work published in the main information systems journals and conferences showed

that research conducted in the area of ERP systems has concentrated on issues related to the implementation phase of the ERP lifecycle [5]. Work contributing to actual ERP operation comprised numerous factors that influence ERP usage depending on users-systems interactions over time based on structuration theory [13] and the behavioural-based theories, frameworks for classifying benefits [16], and barriers and challenges to the attainment of ERP benefits [7]. The latter article indicates that implementations do not live up to their expectations and do not provide the expected range of benefits. Another article on ERP performance indicates based on the sample of 50 companies implementing ERP packages from 1993 to 1997 a significant increase in costs as a percentage of revenue and a decrease in the number of employees as a percentage of revenue in the year after ERP implementation. It was reasoned that cost drivers connected to the ERP technology such as (external) ERP system engineers and on-going fixes and fine-tuning elevate costs.

This research project is concerned with the following three key aspects of IT governance [6, 11]:

- (i) strategic planning and alignment as well as top-level management responsibility,
- (ii) IT value delivery, and
- (iii) IT controlling (employment of criteria and standards for decision making and controlling for continuous improvement of IT enabled business processes).

Through an empirical study, it seeks to assess the levels of achievement in each category with respect to ERP system management. Motivated by the many critical perceptions of ERP system operation provided by research, a main goal of this article is to assess the organisational impact of system implementation through a holistic multi-dimensional approach. The framework draws on classifications of possible ERP benefits, on general firm level success measures, and on key performance indicators used in a balanced scorecard adopted to control ERP operation.

Due to the pervasive nature of ERP systems, our results should be of interest for a wide range of professional and scholarly communities apart from the information systems (IS) field. The results presented should assist business management facing the important task to monitor and control ERP system operation. At least, this work raises the awareness for relevant factors that need to be assessed in ERP environments.

II. Methodology

The methodology employed is an industry independent empirical survey undertaken in the years 2003 to 2004. The target group was defined as containing Austrian small to medium sized enterprises (SMEs) as well as large enterprise (LEs) allowing for controlling the size of the company in data analysis. Austria is an example for a well-developed country within the European Union. To avoid under representing the large enterprises in the sample, a stratified and disproportional sample with subgroups according to company size was defined. One thousand Austrian SMEs and LEs were randomly selected from firms listed in a comprehensive, pan-European database containing financial information on 7 million public and private companies in 38 European countries [2].

The questionnaire developed for this study was based on a previously undertaken ERP related study [1], on a review of the literature and on recommendations of a panel of ERP experts from two universities in Austria and the United Kingdom. Following an empirical design method, the panel was asked to critique the questionnaire for content validity [3]. According to their suggestions, the questionnaire was revised and used in Pre-Tests applied in the UK and Austria. Responses were examined to optimize the formulation of each question and ensure consistency in the way they were answered. The questionnaire contained a general section assessing the background information on the company especially IT/IS related and performance related questions. The assessed topics were structured in four sections following the ERP system lifecycle: adoption decision, acquisition, implementation, use and maintenance. Companies were contacted through a multi-staged procedure. A cover letter, the hardcopy questionnaire, and a self-addressed stamped return envelope were sent to business management of the 1000 companies. The package explained the purpose of the study, promoted participation in the survey, assured confidentiality, and offered an ERP-related collection of material on CD as well as a summary of the results together with an opportunity to engage in further research activities with our research department. The questionnaire was also provided in an electronic version to further strengthen the participation. Two weeks after the initial mailing, follow up calls were made to all companies that could not be identified as respondents, asking them for their interest in participating and if cooperative for an email address. Short after these calls, reminder/thank you emails were sent out. The next round of contact consisted in reminding 400 randomly selected companies via telephone calls that they had not yet responded, and again giving them the address and logins for the online questionnaire. Finally, 209 valid returns were registered, resulting in an above average response rate of 22%. Some companies could not be contacted, because they had ceased to exist, the address was wrong or could not be found, etc. These neutral dropouts (49 companies) were considered in the calculation of the

response rate and therefore did not decrease the return quota. To test for non-response bias, known distributions of variables available through the used corporate database were assessed. The analysis revealed no significant different characteristics between non-respondents and respondents. The data was analyzed using a statistical package offering the ability to work on complex samples.

III. Empirical Results

III. 1 Sample Demographics

Following a commission recommendation of the European Communities concerning the definition of micro, small and medium-sized enterprises [4], this research classified as SME an enterprises which employs fewer than 250 persons and which has an annual turnover not exceeding EUR 50 million. Table 1 denotes the firm size and branch distribution of the data sample. The branch classification was based on the core codes given in brackets of the North American Industry Classification System (NAICS) which has replaced the U.S. Standard Industrial Classification (SIC) system in 1997 [12].

Table 1. Firm size and branch distribution

Size	No. of companies (rel. in %)	No. of companies (abs. unweighted N)
SMEs	92.8	129
LEs	7.2	79
Total	100	208
Branch		
Trade (42,44-45)	22.6	58
Manufacturing (31-33)	21.0	60
Construction (23)	20.5	20
Services (54)	15.7	30
Transportation and Warehousing (48-49)	7.6	8
Information (51)	4.5	8
Health Care and Social Assistance (62)	1.9	4
Management of Companies and Enterprises (55)	1.4	8
Other	4.8	12
Total	100	208

The observed distribution of management structure is given in Table 2. The traditional functional management structure was observed in 64.7% of the cases followed by the project/team structures in 16.1% of the enterprises.

Table 2. Management structures

Management structure	Rel. in %
Functional	64.7
Divisional	5.1
Geographic	1.0
Project/Team oriented	16.1
Matrix	7.6
Network (core and periphery)	0.8
Virtual	0.0
Other	4.7

ERP diffusion along the system's lifecycle stages is denoted in Table 3. 15.5 % of all SMEs have already selected an ERP system, i.e. have reached at least the stage of implementing the system, comparing to 67.6 % of all LEs. As expected, the observed differences between SMEs and LEs are highly significant (χ^2 , $p=.00$). The company's positions in the lifecycle correlate positively with organisational size ($\text{corr}=.16$, $p=.03$).

Table 3. ERP diffusion among SMEs and LEs

Stage	All companies		SMEs		LEs	
	%	cum. %	%	cum. %	%	cum. %
Consideration	6.6	6.6	6.6	6.6	6.4	6.4
Evaluation	.5	7.1	.3	6.9	2.0	8.4
Implementation	1.2	8.3	.4	7.3	10.5	18.9
Stabilisation	1.8	10.1	1.8	9.1	2.0	20.9
Usage and maintenance	13.4	23.5	11.4	20.5	39.0	59.9
Extension	2.9	26.4	1.9	22.4	16.1	76
No ERP	73.6	100	77.5	100	23.9	100

III. 2 Strategic Planning in Perspective

Business management has in only 25.8% of all cases explicitly defined their IT/IS strategy (regardless of their ERP utilization stage). Among LEs, the rate is 48.2%, still a remarkable low number. The mean rate of alignment of corporate respectively business strategies and structures with IT/IS strategies and infra-structures on a scale between 1 (very bad) to 5 (very good) is 3.13 revealing a slightly positive assessment. Selection criteria were derived from the strategic goals of the company in 65.3% of all cases. Again, the number increases among LEs, which in general are known to possess a better developed managerial competence. An indicator for top-level management responsibility is the inclusion of the CIO in the board of executives. In 41.9% of all cases, the IS/IT division is represented at board level.

Table 4. IT/IS strategic guidance

	All	SMEs	LEs	p (χ^2)
IS/IT division represented at board level	41.9%	41.8%	43.6%	-
Explicitly defined IT/IS strategy	25.8%	23.8%	48.2%	.00
Strategic Alignment ¹	3.13	3.11	3.51	.04
Strategic concept driving the choice of selection criteria	65.3%	63.7%	76.9%	-

¹ Rated on a scale between 1 (very bad) and 5 (very good), * $p<.05$, ** $p<.01$; N (SMEs) = max 39, N (LEs) = max 59

III. 3 ERP Value Delivery in Perspective

A comprehensive list of ERP decision making criteria were evaluated according to expectations/targets set prior to system implementation. The expectations of business management were most likely met in terms of the system related features "Y2K readiness", "systems reliability", and "EURO currency conversion". The first and the third criteria were among the most important drivers for ERP software growth in the last decade. The expectations of ERP as technology enabler (including e-business, CRM, and SCM) were considered as the least successful aspects. According to the inquired list of all other remaining factors, expectations were at least met at the desired level in the mean case. The list of remaining factors comprised (given in the order of achieved success): "advanced technology", "enabler for desired business processes", "business process improvement", "improved service levels", "integrated and better quality of information", "system interoperability", "system usability", "organizational fit", "increased organisational flexibility", "enhanced decision making", "incorporation of business best practices", "reduced cycle times", "increased customer satisfaction", "short implementation time", "internationality of software", "software costs (licenses, maintenance, etc.)", "operating system independency", and "improved innovation capabilities". No substantive differences were detected in the perceptions given by managers of SMEs and LEs.

An often mentioned short term effect of large scale software introductions is a decline in process efficiencies, respectively organisational performance. This was confirmed by data analysis (see Table 5) and a significant difference was observed between SMEs and LEs (χ^2 , $p=.00$). While the majority of SMEs are faced with short term declines, only a minor number experience long term problems, and no SMEs has stated that the performance level prior to ERP were not recovered. The situation is different among LEs where a considerable proportion faced long term performance problems, while a minor, but nevertheless existing, proportion does not recover to past performance levels.

Table 5. Decline in organisational performance after switching to ERP

Decline in organisational performance	All (%)	SMEs (%)	LEs (%)
not noticed	30.7	25.1	52.2
experienced over a short period of time	60.6	69.3	26.8
experienced over a long period of time	8.3	5.6	18.8
experienced and not recovered	.5	.0	2.2

The question whether ERP is aiding to the organisation to gain a competitive edge was answered with yes by 83.1% of all enterprises. The view is clearly more optimistic in SMEs, i.e. the distribution is significantly dependent on the size of the organisation (χ^2 , $p=.01$). The rate increases to 88.1% for SMEs and decreases to 65% for LEs.

III. 4 ERP Controlling in Perspective

In terms of ERP controlling, only 3.4% of the enterprise in the survey have implemented an instrument to control ERP system operation. In evaluating the performance in the usage stage traditionally two different perspectives, the financial and the technical view, can be defined. The balanced scorecard (BSC) is a well known approach used for controlling based on multiple attributes aligned along four different perspectives. It was first proposed in 1992 [8] and soon after applied [9]. The BSC is a well established measurement method which links strategic objectives and performance measures. Its application promises strategy mapping between each of the perspectives. The idea of a BSC is to find a set of measures that maintain a balance between short- and long-term objectives, between lagging and leading indicators, between financial and non-financial criterions, and between internal and external performance perspectives [10, 14]. To assess the performance in system usage, this study has drawn on suggestions provided in academic literature, mainly on [15] where the BSC was developed for ERP controlling. denotes the four considered ERP controlling perspectives with attributed measures (see Table 6). Based on the gathered data, the overall conclusion is that ERP impact in terms of all measured dimensions provided positive effects in SMEs as well as LEs.

Table 6. Control variables in relation to the situation prior to ERP accross balanced score card perspectives

	All comp.		SMEs		LEs	
	ME	SD	ME	SD	ME	SD
Financial perspective ¹						

Procurement costs	3.36	0.88	3.33	0.90	3.48	0.85
Inventory holding costs	3.21	0.99	3.14	1.02	3.46	0.91
Transportation/logistics costs	3.16	0.76	3.12	0.77	3.30	0.77
Hardware/Technology costs	2.93	0.80	2.95	0.84	2.87	0.70
IT/IS maintenance costs	2.83	1.14	2.96	1.11	2.39	1.23
Overall IT/IS costs	2.79	0.96	2.94	0.87	2.31	1.13
IT/IS consulting costs	2.67	0.91	2.74	0.85	2.41	1.11

Customer (supplier) perspective

	ME	SD	ME	SD	ME	SD
Coverage of business proc ²	3.94	1.18	4.03	1.12	3.81	1.35
Transactions (deliveries,...)	3.62	0.71	3.62	0.71	3.64	0.77
Problems with order	3.56	1.04	3.61	1.07	3.41	0.96
Communication with supplier ¹	3.17	0.85	3.06	0.83	3.61	0.84

Internal process perspective²

	ME	SD	ME	SD	ME	SD
Availability of ERP services	3.96	0.84	3.98	0.88	3.89	0.77
Average time to upgrade	3.31	1.05	3.36	1.07	3.11	1.04
Release levels lagging behind ³	1.34	0.76	1.19	0.62	1.54	0.91
Effectiveness/Productivity	3.86	0.70	3.87	0.62	3.84	0.97
Efficiency/Profitability	3.82	0.79	3.84	0.72	3.74	1.05
Financial close cycle	3.55	0.96	3.46	0.94	3.84	1.01
Probl with reports on demand	3.53	0.95	3.55	0.95	3.47	1.01
Probl with warehouse proc	3.41	0.90	3.42	0.91	3.40	0.93
Probl with standard reports	3.37	1.05	3.28	1.06	3.66	1.05
Exploited ERP functionality ⁴	66.1	20.7	61.73	19.0	73.39	23.4

Innovation and Learning perspective⁵

	ME	SD	ME	SD	ME	SD
Training hours per developer	3.24	0.88	3.29	0.86	3.02	1.03
Training hours per user	2.94	0.76	2.93	0.73	2.95	0.96

¹ Rated on a scale between 1 (poor rating/higher costs) and 5 (good rating/lower costs) in comparison to the situation prior to ERP adoption

² Rated on a scale between 1 (poor rating/decreased) and 5 (good rating/increased) according to planned level of support

³ Rated on a scale between 0 (no lag) and 3 (3 levels behind)

⁴ % of the implemented ERP system functionality

⁵ Rated on a scale between 1 (increased) and 5 (decreased) in comparison to the situation prior to ERP adoption

IV. Conclusion

This article delivers an empirical overview of main components in IT governance with respect to ERP.

First, and often seen as most important, the rationale behind ERP was analysed in a strategic context. The main pre-condition of IT-governance – the alignment of business and IT strategy – is still underdeveloped in the Austrian marketplace. Only a minority explicitly defines their IT strategy. Approximately 25% of the large enterprise have evaluated and selected an ERP system without considering the strategic needs of their company. IT governance implies the IT responsibility of the executive board, but the data showed that CIOs are not regularly seen as members of the board (41.9%).

Second, ERP value in perspective shows that ERP in general meets and often exceeds expectations with respect to almost all assessed areas. Only in terms of enabling other applications such as customer relationship management (CRM) and supply chain management (SCM), ERP seems to fall short in terms of expected utility. This finding contradicts the critical perception of ERP success reported in academic literature given in the introduction of this article.

Organisational performance has declined in 60.6% of the enterprises shortly after implementation, but has recovered in almost all cases to prior levels (known as short dip in organisational performance after switching to ERP). A large majority (83.1% of the cases) believes that ERP is aiding to the organisation to gain a competitive edge.

Third, the quasi non-existence of ERP control procedures in the Austrian market place contradicts the need for IT-controlling (and –governance) mechanism, which is communicated in international IT/IS practice. Due to the documented importance of installed ERP systems respectively of the data and business processes they support, their omission in IS/IT controlling seems critical. This paper can help to introduce controlling in organizational practice through a BSC based approach by providing a list of reference with performance indicators. The empirical data revealed distinct positive effects of ERP in terms of all four BSC perspectives. The financial perspective showed that while IT/IS related costs have approximately remained unchanged, related costs in functional areas, e.g. procurement or logistics, have been reduced due to ERP. The positive valuation of ERP effects becomes more pronounced beyond a financial assessment, e.g., in terms of process efficiency and effectiveness gains.

To summarize, the main findings comprise the observed positive impact of ERP in a holistic, multi-dimensional perception and underdeveloped IT governance principles in Austria. The latter area constitutes a large market potential for consultants who deliver IT re-organisations especially based on new standards (COBIT, ITIL, ISO) or regulations (Sarbanes-Oxley, Basel 2). Future work will concentrate on compliance and substantive tests within case studies with regard to the mentioned frameworks.

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E-Grocery Shopping Trends in the U.S.

Jay Singh*, S. Paul Singh**, Uruchaya Sonchaeng***

* Corresponding author , Assistant Professor, Orfalea College of Business
California Polytechnic State University, San Luis Obispo, CA 93407, USA
Phone: (805) 756 2129, Fax: (805) 756 6111, email: jasingh@calpoly.edu

**Professor, School of Packaging,

Michigan State University, East Lansing, MI 48824, USA

Phone: (517) 355 9580, Fax: (517) 353 8999, email: singh@msu.edu

***Research Assistant, School of Packaging,

Michigan State University, East Lansing, MI 48824, USA

Phone: (517) 333 3961, Fax: (517) 353 8999, email: sonchaen@msu.edu

Abstract: By June 2002, there were 17 grocers in the U.S. and Canada offering delivery services that allowed customers to order via the Internet or telephone. Within these grocers, some such as Peapod and FreshDirect offer services through the Internet without owning any retail store front while some supermarkets like Albertson's, Safeway, Publix and Tesco have developed their online grocery services as another shopping option for their customers. Studying the profile of online grocery shoppers and their behaviors can help businesses to develop and improve their strategies. This paper will discuss the findings from a survey (1516 respondents) on e-grocery in the United States. Responses to such topics as demographics & psychographics, shopping patterns, online shopping experiences, mental, physical and time related considerations, opinions about shopping and buying on the internet and order sizes are discussed.

Keywords: Operations strategy for e-commerce, e-grocery, consumer survey

I. Introduction

The Internet has become a viable way for conducting business. Its capability for communication between individuals without regard of geographic locations allows businesses to develop their markets worldwide. With the increasing number of Internet users and greater endorsement of customers for online shopping (Geissler 2002), the Internet can help businesses reach their customers in a shorter time and at a lower transaction cost (Kirkpatrick, 2002).

Among the growing number of online businesses, the online grocery market is a category that has been discussed widely for its suitability for e-commerce (Anckar et al. 2002). Despite the collapse of some high profile operators like Webvan, Streamline and HomeGrocer (Berning et al, 2004), recent research indicates continued growth in this e-grocery segment is slated to reach as much as \$11.3 sector (Kornum and Bjerre, 2005). By some predictions the Billion by 2006 (Berning et al, 2004). In the United States the

bigger trend is high value grocery items such as premium meats and seafood, and assorted fresh fruits (Singh, 2005)

II. E-Grocery

According to Berning et al, 2004, e-grocery may be defined as *"a firm that uses the Internet to sell a full range of perishable items such as meat, fresh produce and frozen products and non-perishable food and drink items, such as breakfast cereals or canned goods. These products are ordered online for pick-up at a physical store or delivery to the customer's home, office or school"*.

Groceries differ from many other non perishable products, such as music and books, which are commonly purchased online. Many grocery products are perishable and therefore time-sensitive in terms of their delivery needs. The term "perishable" is used for those goods that are not pantry items and need to be stored in a refrigerator or a freezer. In addition, groceries are a replacement product, i.e., the same basket of products is more-or-less purchased on a regular basis (Kempiak and Fox 2002). Finally, some groceries are dependent on organoleptic (touch, smell, and sight) experiences, meaning that consumers like to inspect the quality of items they are purchasing. Even though the freshness and quality of the products can be guaranteed by the business, consumers still have difference preferences and acceptance standards for certain kinds of grocery products (Anckar et al, 2002). With these reasons, groceries could be considered as product category that is not suitable for online business. However, researches show that there are many factors for online groceries to thrive in the world of e-commerce. Many consumers dislike the chore of grocery shopping (Corral 1999) and many of them even have shopping stress (Aylott and Mitchell 1998). Thus, convenience and time saving can be dominant reasons for consumers to shop for groceries online. According to one survey report (Chiger 2001) 67% of the online shoppers agreed that convenience was the main reason they had bought via the Internet with 41% mentioning price as another factor.

E-grocery business models

Socioeconomic characteristics such as the ever growing demand on consumers' time, increased wealth, and

heightened levels of stress in consumers' everyday lives have influenced the growth of E-Commerce in general. The high total cost of E-grocers' picking and distributing items from a wide range of possible products and consumers learning to shop online may be delaying the wider adoption of such E-Commerce by grocers and consumers alike (Lim et al, 2004). As reported in June 2002, there were 17 grocers in the U.S. and Canada offering delivery services that allowed customers to order via the Internet or telephone (Geissler 2002). Slowly but surely, retailers are coming back with two basic business models — online ordering piggy-backed onto existing supermarkets, and the so-called pure-play approach, which seemed in danger of dying off after the Webvan conflagration, but now has resurfaced with a much more specialized way of doing business (Lempert 2005). Some large supermarket chains such as Albertson's, Safeway, Publix, Tesco, etc., opt for the first choice (i.e. store-based e-grocers). Examples of the pure-plays (i.e. grocers without physical store) are Peapod and FreshDirect.

Brick-and-mortar add-ons

Brick-and-mortar companies had been reluctant to fray into the e-grocery market for a long period of time. It is the entrance and the perceived success of the pure-plays that has caused them to reevaluate their strategy. The brick-and-mortar add-ons can be categorized as those that sell online themselves and those that establish partnerships with pure-plays (Lempert 2005). Despite its potential advantages, the pure-play model has its drawbacks.

1. Brick-and-mortar stores have established locations, brand names, and a large customer base.
2. A majority of consumers still prefer to buy groceries from a retail store. They may like to smell the vegetables and squeeze the fruit, or they may like to unwind from a long day by walking among the fresh breads of the bakery.
3. Consumers also trust the grocery stores they have known for many years, and like to shop where they feel assured the quality is consistent and the price is right.
4. Probably the biggest challenges for pure-plays are in order fulfillment and home delivery. Supermarkets aggregate demand by allowing customers to come to the stores, and therefore customers do the order picking and delivery. According to Procter & Gamble, traditional in-store shoppers who pick, pack, and deliver their own products now save the industry approximately 13 percent of the total cost of sales (Tapscott and Ticoll, 2000).
5. For e-grocers, the more deliveries in a given area, the lower the costs per delivery. Except for a few cities, Americans who can afford computers and Internet access are more likely to live in suburbs, which means more driving and fewer deliveries per hour for any company that offers home delivery.

Pure-play online e-grocers

Over the past decade the number of defunct e-grocers, including Webvan, HomeGrocer, Shoplink, and Kozmo, have far outnumbered the survivors. From a business perspective, the pure-play (no retail storefronts, only web ordering and delivery, and possibly one or more warehouses) e-grocer model has several advantages over the traditional retail grocery model (Hays et al, 2004).

1. E-grocers do not have the high costs associated with multiple retail locations, including rent, parking, and high property taxes.
2. By "pooling" their inventory in fewer locations, e-grocers can better manage their inventory, reducing inventory holding costs and increasing inventory turnover rates. This leads to less spoilage of products and shorter lead times from the producer to the consumer, key advantages in selling perishable products.
3. E-grocers can collect detailed information about their customers' buying habits and preferences, which can then be used for targeted marketing and personalized promotions. Such one-to-one marketing is what the traditional grocers are trying to do by using loyalty cards to track purchases.
4. E-grocers may generate incremental sales growth for the industry. Although many retailers and consumers believe that impulse purchases diminish online, some companies such as Amazon.com have been able to foster impulse selling quite well with innovative marketing.

III. Summary of the Survey Results

It is still not certain whether e-grocers would lead to successful businesses or not. Some online grocers such as Webvan, Streamline, and Homegrocer have failed to continue their businesses. However, some still survive and many supermarket chains are starting to offer online services as an option for their customers. Socioeconomic characteristics such as growing demands on consumers' time, increased wealth, and heightened levels of stress in many regular situations are among those factors that dramatically change many consumer markets. Ideal customer characteristics for the e-grocery segment of the Internet business have been studied by various surveys (Berning et al, 2004). Defining the ideal customer is intended to explain the low adoption rate within the e-grocery sector and if e-grocers are entering the correct geographic segments. Studying the profile of online grocery shoppers and their behaviors can help the businesses to develop and improve their strategies. According to one study (Berning et al, 2004), an ideal customer is a female aged between 25 and 44 years, likely belongs to a dual income household with income greater than \$50,000, has children and is likely to have a college education. The study also concluded that convenience was the largest factor for e-grocery customers.

This paper discusses the findings of a survey on e-grocery in the United States. This survey was conducted by

Survey International Inc. on the internet with customers in Chicago, IL, Boston, MA, New York, NY, Seattle, WA, and San Francisco, CA. Responses to issues such as demographics & psychographics, shopping patterns, online shopping experiences, mental, physical and time related considerations, opinions about shopping and buying on the internet and order sizes from 1516 respondents are discussed in the following section.

Respondent demographics and psychographics

- A majority of the respondents were females (77% of 1516 respondents).
- 32% of the respondents lived with 2 persons in the household and 62% had no children under the age of 16.
- Respondents were educated as 26% of them reported to finish short-advanced study (up to 2 years duration) and 25% finished medium-advanced study (up to 4 years duration).
- Major range of ages for the respondents was 30-55 years.
- The gross income of the household ranged between \$37,000 and \$49,000.
- 40% of them spent \$150-\$299 each month on groceries while 26% spent \$300-\$449.
- Most respondents lived in New York (36%) and Illinois (26%).
- Almost all of them (96%) had cars and of these, 42% had 2 cars in a household. 25% of them had bicycles and 4% had motorcycles.
- 65% of the respondents owned their houses.

Considering the internet experiences of the respondents, the results can be summarized as follows. Most respondents (95%) had access to the Internet at home, 53% had access to the Internet at work or educational establishment, 52% had access to the Internet at family, friends or acquaintances and only 19% had access to the Internet at other places than those mentioned before.

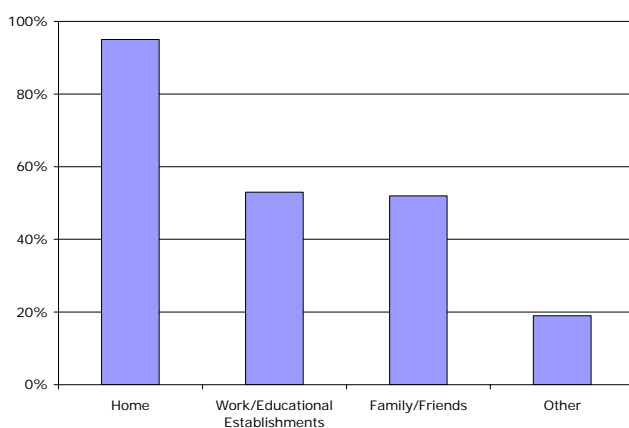


FIGURE 1: INTERNET ACCESS LOCATION FOR RESPONDENTS

Most of them never (73%) or rarely (18%) used the Internet at a library or at an Internet café. Most of them

(72%) used the Internet daily at home and 33% used the Internet daily at work or educational establishment. They rarely used the Internet at family, friends or acquaintances (46% answered “never” and 33% answered “less than 1 time per month”). Most of them (87%) never used the Internet at other places than those mentioned above.

Most of the respondents had used the Internet for more than 3 years. When asked about the first time the respondents had experienced the Internet, it had been more than 6 years for 40% of them, 5-6 years for 23% of them, and 3-4 years for 26% of them. More than half (54%) of the respondents spent more than 10 hours on the Internet during a normal week, irrespective of whether it is related to work, education or leisure. 54% of them considered themselves to have a moderate expertise in the Internet use, while 28% considered themselves to have a basic expertise.

Considering what the respondents found important to their lives, the following results are found from the survey. Values that were ranked most as “*extremely important*” to the respondents’ lives were - to obtain safety for their loved ones (70%), to have freedom of action and thought (65%), to enjoy life (61%), to have close friends (42%), to be competent, effective and efficient (41%), and to have a varied life (36%).

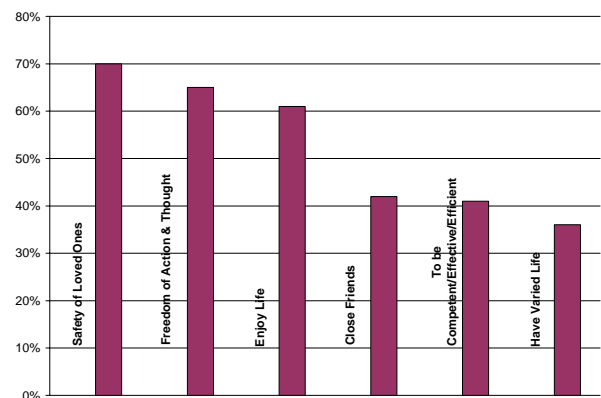


FIGURE 2: VALUES “EXTREMELY” IMPORTANT TO RESPONDENTS

Values that were ranked most as “*very to extremely important*” to their lives were; to have self-respect (60% extremely and 25% very important), to live a healthy life (53% extremely and 25% very important), to be polite (46% extremely and 26% very important), to be tolerant to different ideas and beliefs (43% extremely and 27% very important), to be helpful (39% extremely and 33% very important), to obtain pleasure in life (38% extremely and 29% very important), to have respect for traditions (33% extremely and 25% very important), and to have self-discipline and to resist temptations (30% extremely and 28% very important). More over, 26% of them ranked the value to protect the environment as “*very important*”.

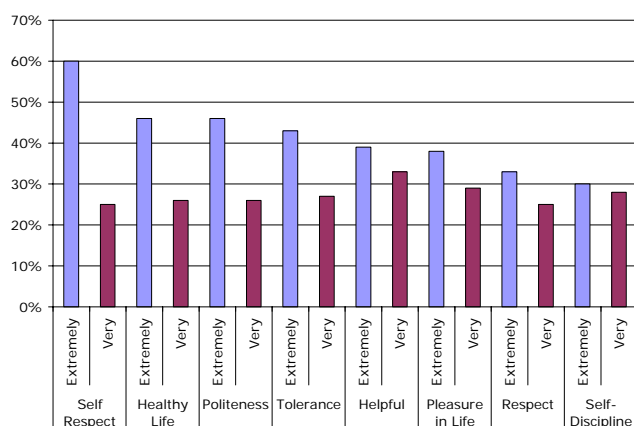


FIGURE 3: VALUES “VERY-TO-EXTREMELY” IMPORTANT TO RESPONDENTS

25% of the respondents ranked the value to have exciting lives as “quite important”. For the value to have an impact on people and events, 26% of them ranked it as “quite important” and another 26% ranked it as “neither important nor not important”. Values that were ranked most as “neither important nor not important” to their lives were - to obtain social recognition and respect (27%), to achieve material wealth (27%) and to avoid extremes of feeling and action (28%).

Shopping patterns

Concerning the responsibility for grocery shopping, more than half (52%) of the respondents did all of the grocery shopping, while 33% did most of the grocery shopping in the household. 55% of the respondents did main grocery shopping at the stores located within 0-3 miles from their houses. 68% of them reported to shop most often at other stores that are not listed in the survey. (Stores listed in the survey include Kroger, Safeway, Wal-Mart, Albertsons, Meijer, Shaw Supermarkets, Osco/Jewels, Aldi, Publix, and Ahold).

41% of the respondents normally bought grocery once a week and 34% bought it 2-3 times a week. Most of them wrote shopping lists before going grocery shopping as shown by the majority responses to this question as “always” (31%), “often” (28%) and “sometimes” (26%). Before going for grocery shopping, more than half of the respondents (61%) “never” looked for special offers on the internet while some of them “always” (36%) or “often” (30%) read special bargain or advertising folders. Half of the respondents (50%) “always” chose the store to shop in advance while 29% “often” did that. 39% “often” chose the product they wanted to buy in advance while 31% “always” did the same thing. About one-third (34%) “often” chose the brand they preferred to buy while 28% “sometimes” and 25% “always” did that.

Questions about how they combined their daily shopping with other activities revealed the following results. Activities that they rarely combined with grocery shopping were - going from workplace, doing grocery shopping and

collecting children (74% answered “never”) and going from workplace, collecting children and doing grocery shopping (73% answered “never”). Combination of a trip from workplace, grocery shopping, and leisure activities as well as a trip from workplace, leisure activities and grocery shopping showed high responses for “never” (48%) however there were also significant responses as “sometimes” (27%). This is similar to the responses to a question about combining a trip from workplace to grocery as 33% answered “never” and 30% answered “sometimes”.

The respondents “sometimes” combined grocery shopping with the following activities; leisure activities (43%), going to the post office, doctor, etc. (52%), shopping commodities e.g. clothes, CDs, books, PC equipment, etc. (49%). The respondents’ answers ranged from “sometimes”, “rarely” and “never” when asked about combining these activities with grocery shopping - visiting family (36% never, 25% rarely, 32% sometimes), visiting friends (34% never, 27% rarely, 34% sometimes), shopping permanent goods e.g. white goods, PC, radio/TV, etc. (25% never, 35% rarely, 33% sometimes), shopping in special shops e.g. cheese monger, fruits and vegetables, etc. (28% never, 27% rarely, 34% sometimes).

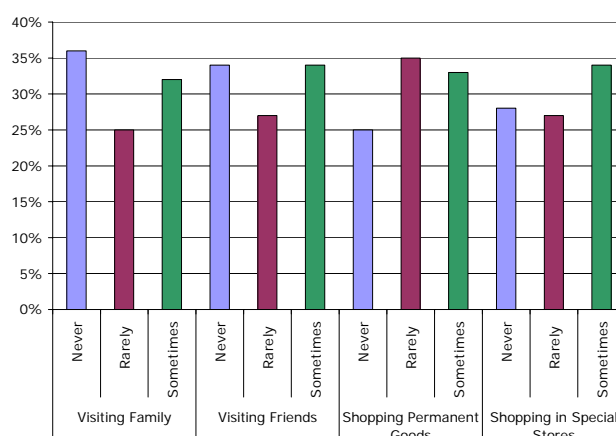


FIGURE 4: RESPONSES TO “SOMETIMES” COMBINING GROCERY SHOPPING WITH OTHER ACTIVITIES

Online shopping experiences

When asked which of the products/services the respondents had looked for information or bought via the Internet, the percentage of positive responses could be summarized in the Table 1 below.

TABLE 1: PERCENT OF THE POSITIVE RESPONSES FOR VARIOUS CATEGORIES OF PRODUCT/SERVICE

Products/Services	Never sought information or purchased online	Sought information on the Internet	Purchased Online
Groceries	54 %	40 %	11 %
Household goods	23 %	57 %	38 %

Products/Services	Never sought information or purchased online	Sought information on the Internet	Purchased Online
PCs	33 %	57 %	20 %
PC Supply (programs, etc.)	30 %	51 %	38 %
Furniture and housing equipment	39 %	54 %	14 %
Medicine	39 %	52 %	16 %
Travels and vacation	20 %	58 %	42 %
Pizza, Fast food (delivery)	76 %	20 %	6 %
Music/videos/books	10 %	53 %	68 %
Toys	30 %	44 %	44 %
Tickets (e.g. theater tickets)	36 %	43 %	36 %
Flowers, gifts for delivery	39 %	39 %	38 %
Personal care items	38 %	43 %	33 %
Accommodation	29 %	51 %	39 %
Insurance	54 %	43 %	6 %
Clothes	23 %	49 %	53 %

It can be seen that more than half (54 %) of the respondents had never sought information or purchased groceries online. However 40 % of them at least had sought information on the Internet and 11% had purchased groceries online. The products/services that were most purchased online based on this survey were music/videos/books (68 %), clothes (53 %), toys (44 %), and travels and vacation (42 %). The respondents sought information on the Internet mostly on these products - travels and vacation (58 %), household goods (57 %), PCs (57 %), and furniture and housing equipment (54 %). The products/services that the respondents less likely sought information for or purchased online were fast foods (76 % “never”), groceries (54 % “never”) and insurance (54% “never”). When asked about how long it had been since the first grocery purchase over the Internet, 80 % of the respondents answered that they had never shopped groceries on the Internet.

Mental, physical and time-related considerations in relation to buying groceries

The respondents ranked the importance of these considerations regarding grocery shopping as follows. They mostly agreed that when they bought groceries, it was important what they chose (51 % strongly agreed and 39 % agreed). It was also important to them that they made the right decision when buying groceries (28 % strongly agreed and 57 % agreed). Many of them (40 %) agreed that usually there is so much to do that they wished they had more time. When asked if they were often in a hurry when they bought groceries, 32% agreed and 28 % disagreed. 29% of the respondents agreed that grocery shopping was something to be dealt with and to finish the sooner the better, while 31 % of them neither agreed nor disagreed. Many of

them (42 %) neither agreed nor disagreed to the statement that there was a big difference between the groceries; however 27 % agreed to that statement.

Almost half of the respondents (49 %) disagreed that they often worried whether they made the right choices when buying groceries. Many (31 %) disagreed that the transportation of their bought grocery products was hard and 27 % neither agreed nor disagreed. 36% of the respondents disagreed that the transportation of their bought groceries was exhausting and 27 % neither agreed nor disagreed. About one-third (35 %) of the respondents disagreed that they liked to shop in stores they were unfamiliar with and another one-third of them (34 %) neither agreed nor disagreed. 37% of the respondents neither agreed nor disagreed that they liked to meet other people in the supermarket while 29 % disagreed. About the same number of the respondents disagreed (29 %) and neither agreed nor disagreed (29 %) that they really liked to visit different supermarkets, however, 25% of them agreed to that statement.

Opinions about shopping and buying on the internet

A majority of the respondents answered that it was *not important* that they could buy the following type of goods at an Internet grocery store; vegetables (73 %), fruit (72 %), meat (70 %), fish (76 %), fillings (73 %), dairy products (72 %), frozen goods (67 %), organic products (77 %). Even though a very small portion of the respondents answered “*very important*” to the above question, the results are shown here for comparison. The importance of the fact that they could find these products can be ranked as the following; fruits (11%), vegetables (11%), meat (10%), frozen goods (10%), dairy products (10%), fish (7%), organic products (5%) and fillings (5%). Figure 5 below shows these findings.

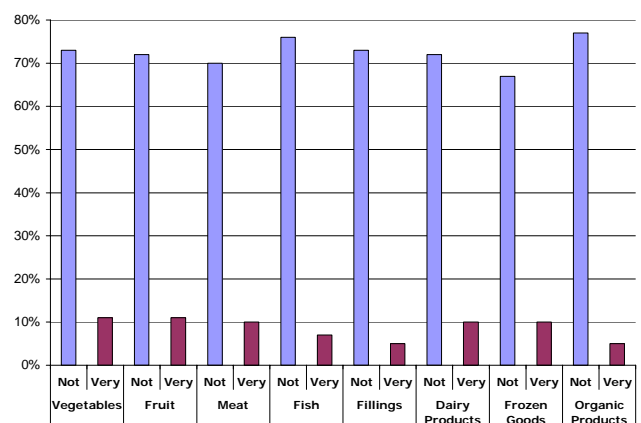


FIGURE 5: RESPONSES TO THE IMPORTANCE OF AVAILABILITY OF VARIOUS TYPES OF GROCERIES ON THE INTERNET

When asked about a reasonable minimum order value that included free packing and delivery when they bought groceries on the Internet, about one-third (31 %) of the respondents answered \$25-\$59. When asked what a

reasonable charge would be if they bought below the minimum order value that they selected, twenty-three percent of the respondents answered \$5-6, while 19% answered \$0-2 and another 19% answered \$3-4.

Most respondents *agreed* that the electronic shopping of groceries was complex because they could not feel and see the products (37% strongly agreed, 39% agreed). Almost half (46%) of the respondents agreed that a risk when buying groceries via the Internet was receiving low quality products or incorrect items. Most of them *disagreed* that buying groceries via the Internet was well suited to the way in which their households normally shopped for groceries (25% strongly disagreed, 34% disagreed).

The majority of the respondents *neither agreed nor disagreed* with the following statements:

- Shopping groceries via the Internet was favorable as it makes them less dependent of opening hours (28% neither agreed nor disagreed)
- Electronic shopping of groceries was easy to fit into their daily lives (31% neither agreed nor disagreed)
- It was hard to find the needed products when shopping groceries via the Internet (43% neither agreed nor disagreed, 26% no opinion)
- With electronic shopping of groceries it was difficult to order products (46% neither agree nor disagreed, 26% no opinion)
- It was easy to compare the prizes of grocery products on the Internet (36 % neither agreed nor disagreed)
- There was a lot of money to be saved when buying groceries on the Internet (45% neither agreed nor disagreed)
- There were too many untrustworthy shops on the Internet (42% neither agreed nor disagreed)
- Security around payment on the Internet was not good enough (33% neither agreed nor disagreed)
- It was difficult to receive groceries purchased via the Internet and to have them home delivered (37% neither agreed nor disagreed)
- There is too many of their preferred grocery products that they could not buy on the Internet (43% neither agreed nor disagreed, 27% no opinion)
- The groceries were often damaged when they received them at home (37% neither agreed nor disagreed, 47% no opinion)
- The cold and frozen goods were often inadequately cold/frozen when they received them at home (35% neither agreed nor disagreed, 48% no opinion)
- They often lacked room at home for returnable boxes (32% neither agreed nor disagreed, 38% no opinion)

The majority of the respondents answered *agree* and *neither agree or disagree* to the following statements:

- Electronic shopping of groceries was less exciting than buying in the non-internet shop (25% agreed, 36% neither agreed nor disagreed)

- Using electronic shopping of groceries saved much time (29% agreed, 34% neither agreed nor disagreed)
- Return and exchange opportunities were not as good on the Internet as in the supermarket/ non-internet shop (34% agreed, 25% neither agreed nor disagreed)
- Possibilities for advice were much too poor on the Internet (27% agreed, 36% neither agreed nor disagreed)
- Arrangement for payment on the Internet was just as safe as every other payment method (28% agreed, 29% neither agreed nor disagreed)
- To have groceries purchased on the Internet delivered at home was too expensive (26% agree, 36% neither agreed nor disagreed)

The majority of the respondents answered *disagree* and *neither agree or disagree* to the following statements:

- Electronic shopping was in general, very complex (30% disagreed, 36% neither agreed nor disagreed)
- Most of their friends and acquaintances thought shopping groceries via the Internet was a good idea (27% disagreed, 34% neither agreed nor disagreed)
- It was easy to compare the quality of groceries via the Internet (30% disagreed, 29% neither agreed nor disagreed)
- In general electronic shopping of groceries was problem-free (26% disagreed, 37% neither agreed nor disagreed)
- Members of their families thought that it was a good idea to buy groceries via the Internet (25% disagreed, 31% neither agreed nor disagreed)
- They often had difficulties at home in disposing of non-recyclable packaging (27% disagreed, 28% neither agreed nor disagreed, 29% no opinion)

When asked about how likely was it that over the next 5 years they would shop for groceries via the Internet, almost half of the respondents (46%) answered *not likely at all*. 41% of the respondents thought that none of their grocery shopping would be carried out via the Internet in 5 years from now while 22% of the respondents answered 1-10%.

Order sizes

In the brick-and-mortar stores, the frequencies that the respondents made large purchases can be summarized in Table 2 and Figure 6 below.

TABLE 2 FREQUENCIES WITH WHICH THE RESPONDENTS MADE LARGE PURCHASES IN THE NON-INTERNET GROCERY SHOPS (N = 1516)

Stores	Frequency of shopping				
	Everyday	1-2/week	Every 2 weeks	1/mth.	Rarely or never
Kroger	1	25	24	25	1441
Safeway	2	55	61	71	1327
Wal-Mart	7	117	171	401	820
Albertsons	2	28	32	23	1431

Meijers	2	13	10	31	1460
Shaws	1	30	24	35	1426
Osco/Jewels	4	80	72	79	1280
Aldi	0	47	67	162	1239
Publix	1	2	9	10	1493
Ahold	0	12	20	7	1476
Other	21	452	341	199	502

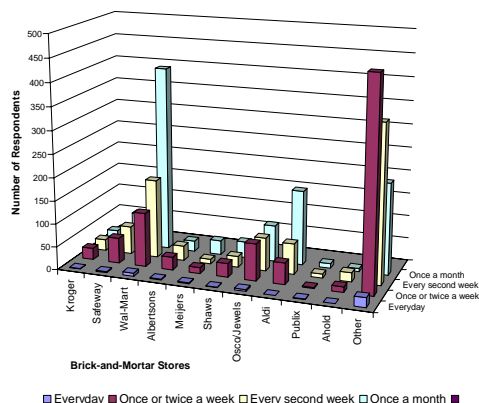


FIGURE 6: FREQUENCIES WITH WHICH THE RESPONDENTS MADE LARGE PURCHASES IN THE NON-INTERNET GROCERY SHOPS (N = 1516)

In the pure-play stores, the frequencies that the respondents make large purchases can be summarized in Table 3 and Figure 7 below.

TABLE 3: FREQUENCIES WITH WHICH THE RESPONDENTS MADE LARGE PURCHASES IN THE INTERNET GROCERY SHOPS (N = 1516)

Stores	Frequency of shopping				
	Everyday	1-2/week	Every 2 weeks	1/mth.	Rarely or never
Safeway	1	19	36	40	1420
Peapod	0	3	16	37	1460
Albertsons	0	12	12	12	1480
Other 1*	14	205	133	126	1219
Other 2*	4	83	78	86	1219
Other 3*	3	27	40	46	1309

* Names of pure-plays are not revealed intentionally

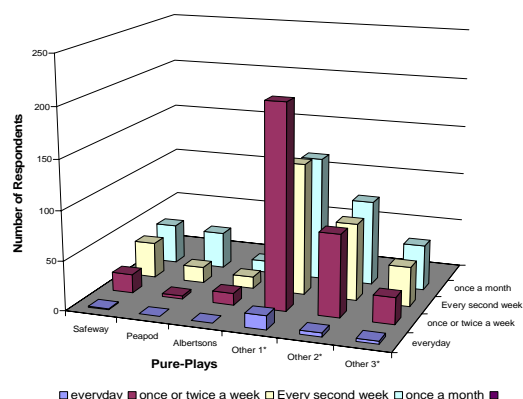


FIGURE 7: FREQUENCIES WITH WHICH THE RESPONDENTS MADE LARGE PURCHASES IN THE INTERNET GROCERY SHOPS (N=1516)

In the Internet grocery shops that went out-of-business, the frequencies that the respondents made large purchases can be summarized in Table 4 and Figure 8 below.

TABLE 4: FREQUENCIES WITH WHICH THE RESPONDENTS MADE LARGE PURCHASES IN THE CLOSED INTERNET GROCERY SHOPS (BASED ON 1516 RESPONDENTS)

Stores	Frequency of shopping				
	Everyday	1-2/week	Every 2 weeks	1/mth.	Rarely or never
Streamline	0	0	8	3	1505
Webvan	1	2	13	13	1487
Homegrocer	0	3	7	7	1499
Other	5	22	25	24	1440

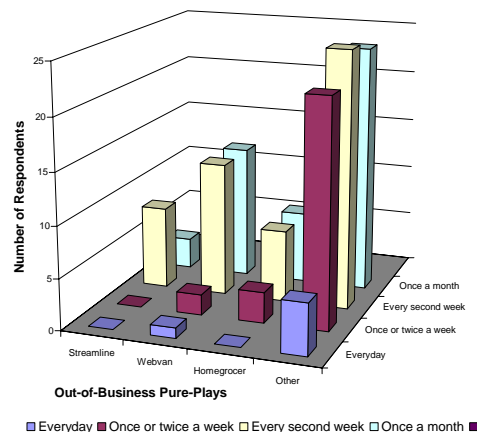


FIGURE 8: FREQUENCIES WITH WHICH THE RESPONDENTS MADE LARGE PURCHASES IN THE DEFUNCT INTERNET GROCERY SHOPS (N = 1516)

A majority of the respondents who made large purchases at brick-and-mortar stores shopped at stores other than those mentioned in the survey as can be seen in Figure 6, above. Figure 6 also shows that within the major stores (that have their names listed in the survey), the respondents made large

purchase most at Wal-Mart, Aldi, Osco/Jewels, and Safeway, in that order.

Even though the respondents did not often make large purchases in the Internet grocery stores, there were a significant amount that sometimes made large purchases from other stores numbered 1, 2, and 3 (names not revealed in the survey results), respectively. Among the 3 Internet grocery stores with their names listed in the survey (Safeway, Peapod, and Albertsons), the respondents bought their groceries mostly from Safeway, as can be seen from Figure 7.

In the cases of online grocery stores that were defunct, the most frequency with which the respondents made large purchases falls into once every other week. The store they shopped most was the store not listed in the questionnaire. For the stores listed, Webvan seemed to be the one they shopped most at, followed by Homegrocer and Streamline, in that order.

When asked about the amount of money the respondents typically spent all together for packing and delivery when they shopped for groceries via the Internet, the results can be summarized as follows. Among 27 respondents who had purchased groceries from Safeway, the amount ranged from \$0-1,500 with most frequencies at \$10 (3 respondents) and \$50 (3 respondents). Among 88 respondents who had purchased groceries from Peapod, the amount ranged from \$0-10,000 with most frequencies at \$100 (14 respondents). Among 9 respondents who had purchased groceries from Albertsons, the amount ranged from \$10-10,000 with varied frequencies. Among 188 respondents who had purchased groceries from Other Shop 1 (name not revealed in the questionnaire), the amount ranged from \$0-20,000 with most frequencies at \$0 (43 respondents). Among 21 respondents who had purchased groceries from Other Shop 2 (name not revealed in the questionnaire), the amount ranged from \$0-5,000 with most frequencies at \$30 (4 respondents). Among 15 respondents who had purchased groceries from Other Shop 3 (name not revealed in the questionnaire), the amount ranged from \$0-5,000 with most frequencies at \$0 (5 respondents).

IV. Conclusion

While the growth of E-Commerce buying and shipping for grocery products has been slow in the United States in the past five years, the trends are increasing. Most consumers

who are shopping for e-grocery are single or small family with relatively higher income levels. There is also a trend to have higher sales per shopping experience per individual customer as compared to in-store purchases. The successful e-tailers have offered this service of e-commerce purchased product with free delivery from their brick-and-mortar stores. The high value perishables are directly shipped to consumers from order-fulfillment centers or distribution centers.

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Toward A New Operations Strategy in the Network Economy

Li Luo^a, Xuejun Xu^a, Minggan Li^b

^aInstitute of New Industrialization, School of Business Administration, South China University of Technology, Guangzhou 510640, China, luoliyh@yahoo.com.cn

^bGD Midea Electronic Appliances Co.,Ltd, Shunde 528300, Guangdong, China

Abstract: The rapid development of information technology has dramatically changed the dynamics of the market and altered the rules of competition. Inter-organization information systems make it possible for firms to achieve effective integration both in decision-making and operations processes, which brings enormous potential for supply chain cooperation. The scope of operations now is no longer confined to plant or strategic business unit (SBU) level. It has expanded to the whole supply chain.

In the network economy, almost every underlying assumption of old economy operations management comes into questions. Competitive advantages making firms success in the old economy may lose their utility in the new IT-based economy. New source of competitive advantages should be identified and cultivated. This study conceptually extends existing operations strategy models: (1) to reflect the substantial change brought by the network economy and the new characteristics of emerging operations mode; (2) by extending the unit of analysis from plant and strategic business unit to supply chain organization; (3) by adding new construct and at the same time extending the connotation of prior constructs used in traditional operations strategy models. A conceptual framework of the new operations strategy is recommended.

Keywords: operations strategy for E-commerce, supply chain, network economy

I. Introduction

Ever since Skinner (1969) pointed out the missing links between the manufacturing function and strategy [1], manufacturing strategy, or what is now called operations strategy, has received considerable attention both in academic world and business world. Manufacturing strategy is often advanced as a source of competitive advantage [2] [3].

The development of information technology has dramatically changed the dynamics of the market and altered the rules of competition. A key feature of present-day business is the idea that it is supply chains that compete, not companies [4]. Competitive advantages in the old economy may lose their utility in the new network economy. A key question that the operations management community needs to consider is whether the tools, models and concepts from the old economy can still serve operations management in

new economy organizations and their evolving business models [5]. Under this circumstance, a new strategic thinking is required in response to the challenge posed by the network economy. As Sampler and Short (1998) state, the new “information-driven competitive dynamics require researchers to develop new theoretical constructs and managerial perspectives to re-evaluate the firm and its extended set of relationships because failure to manage information and information-related resources can produce undesirable side-effects” [6].

This paper first examines the basic assumptions underlying traditional operations strategy. New factors and characteristics that should be taken into account in the formulation of operations strategy are then identified. Based on the work of existing literature, mainly the work of Hayes and Wheelwright, a conceptual framework incorporated the influence of new environment is presented.

II. The Impact of the Network Economy and the Limitation of Existing Operations Strategy Models

Hayes (2002) identifies five underlying assumptions of old economy operations management [7].

- (1) The organizational unit of analysis is an operating unit (e.g. factory, company, division or business unit of a company);
- (2) Operations management is primarily concerned with stable “products” and “processes”;
- (3) The dominant activity of the operations manager is to control the flow of materials (and/or information) through a sequence of process steps;
- (4) A major concern of operations managers is reducing the variable cost of production;
- (5) Your competitors are your enemies, and the key to prevailing against them lies in differentiation (e.g. through lower cost and superior performance, etc.).

Yet, in the network economy, almost all of these underlying assumptions come into questions. With the advent of inter-organizational information systems, and E-business in particular, electronic links between separately owned organizations could be established, which brings enormous potential for the supply chain partners to develop and enhance their cooperation. Therefore, within the context of the network economy, more factors should be taken into account in the process of operations strategy formulation.

(1) The network characteristics of the new operations mode should be incorporated. The scope of operations

strategy should be extended from a single operations unit to the whole supply chain..

(2) Besides “products” and “processes”, supply chain relationship should also be included as a primary decision area in response to the dramatic increase of reciprocal interdependencies between separate organizational units in the supply chain.

(3) Cooperation instead of competition should be emphasized.

III. Operations Strategy and Structure: A Brief Literature Review

Since Chandler’s seminal study in 1962 [8], the strategy/structure approach has been widely used in strategic management literatures. Review of the operations strategy reveals that structure decisions lies at the heart of traditional operations strategy field. Hayes and Wheelwright (1984) categorized the decision elements of operation strategy as structural and infrastructural. Structural decisions included those relating to capacity, facilities, production equipment and systems, and internal/external sourcing. Infrastructural decisions included human resource policies, quality systems, production planning, new product development, organization and performance measurement [2]. Nigel and Michael (2002) [9] held a different view. According to their analysis, all the decision areas have both structural and infrastructural implications. It is inadequate to categorize decision areas as being either entirely structural or entirely infrastructural.

The product-process matrix proposed by Hayes and Wheelwright [2] describes manufacturers’ choices about manufacture structure along two dimensions: process structure and product structure. Process structure ranges from the relatively unstructured job-shop environment to the highly structured continuous-flow production environment. The product structure dimension ranges from low standardization in product design (highly customized products) to commodity-like products that are highly standardized [10]. The underlying assumption of the product-process matrix is that the fit between process structure and product structure results in superior performance.

In their generic manufacturing strategy model, Kotha and Orne (1989) [11] defined manufacturing structure along three dimensions: process structure complexity, product line complexity and organizational scope. Process structure complexity in this model includes the traditional concept of process maturity [2] but has a broader scope. It has three sub-dimensions: (1) the level of mechanization of production processes; (2) the level of systemization of production processes and activities; (3) the degree of interconnection of production process tasks and stages. Production line complexity is a measure of the type and variety of product lines which could be represented by the complexity of end-products produced, individual product volumes and end-product maturity or experience. Kotha and Orne (1989) did not explicitly define organizational scope

but indicated ‘underlying variable’ of the third dimensions including geographic manufacturing scope, geographic market focus, vertical integration, customer-market scope, and the scale [10].

The scope of operations strategy evolves over time. The unit of analysis of Product-process matrix and generic manufacturing strategy model are two typical examples to reflect the evolution process. The product-process matrix was developed at the plant level, while the generic manufacturing strategy framework was developed at the strategic business unit (SBU) level. Yet most of the operations strategy models are developed in the context of old economy. Little work to date that integrates the characteristics of the operations in the network economy has been made.

IV. A Conceptual Framework of the New Operations Strategy

The authors agree with Nigel and Michael (2002) that the structural and infrastructural decisions in operations strategy are interwoven. Therefore, this paper does not distinguish the two concepts. Based on existing operations strategy literatures and relevant organization theories, this paper extend the traditional operations strategy frameworks by including aspects relating to inter-organizational supply chain management facilitated by the rapid development of information technology. Two core categories of elements of the new operations strategy are operations performance objectives and strategic decision areas. Figure 1 illustrates key elements of operations strategy and their interdependences.

IV. 1 Operations performance objectives

Objective reflects the state that a system is expected to achieve. The operations performance objectives reflect the aspects of operations performance that satisfy market requirements and therefore define what the operation is expected to pursue. Many authors on operations strategy have designed their own set of performance objectives. Similar constructs in the literature include “manufacturing task”, “competitive priority” and “competitive capability”. Though differences exist between definitions made by different authors, there are some commonly used categories. Four commonly accepted performance objectives are quality, speed, cost and flexibility. Quality refers to both product quality and service quality. Speed reflects how fast customers’ needs, also including product and service, can be met. Cost includes all the financial input required to satisfy customers’ needs. Flexibility indicates the ability to adapt to the change of customer requirement.

IV. 2 Strategic decision areas

The first strategic decision area is product structure. The structure of products manufactured is an important characteristic of manufacturing environments. According to

the product-process matrix, this reflects the maturity of the product life cycle stage [10]. The product structure construct here encompasses five sub-dimensions:

- (1) Primary product type or product life cycle stage;
- (2) Variety of final product;

- (3) Volume of each final product;
- (4) Customization/standardization of final product;
- (5) Compositions and modularization of key components of final product.

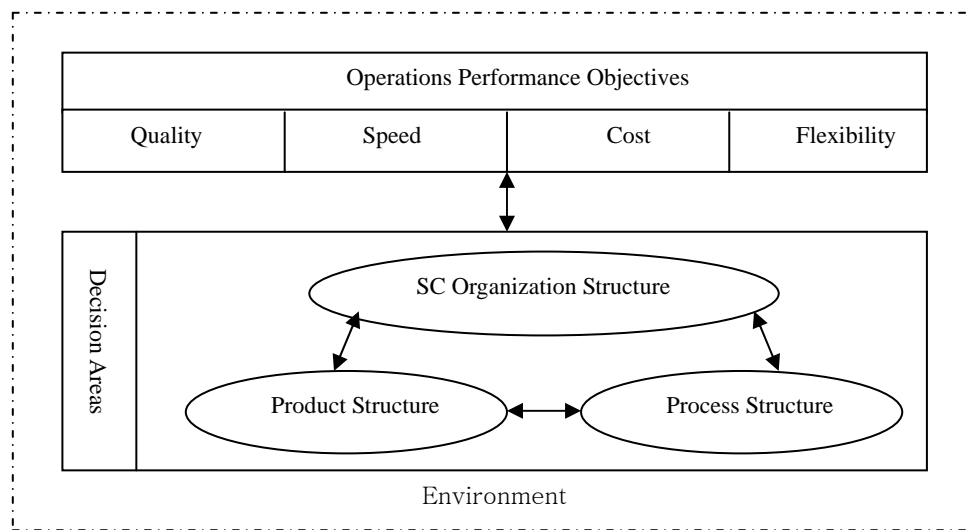


Figure 1 Key elements of operations strategy and their interdependences
Fig.1 Supply chain strategy analysis elements and decision areas

IV. 3 The external fit and the internal fit of operations strategy

The main tasks of operations strategy are identifying key elements of strategic operations decisions and integrating these elements in a pattern so that two kinds of “fit” can be achieved. The first fit is external fit or environmental fit. The external fit concerns how the operations strategy matches with the environment. The second fit is internal fit, including the fit among different structures and the fit between objectives and structures. Harmonized together, the whole of these mutually supportive elements can be a far greater source of competitive advantage than any single elements of the strategy.

V. Conclusions

Most of existing operations strategy models are developed in the context of old economy. Review of the operations strategy literature reveals that little work to date has been made to integrate the characteristics of the operations in the network economy. Our intentions in this paper are to extend the traditional operations strategy models in the context of network economy by incorporating factors enabled by the rapid advancement of information technology. A conceptual framework that demonstrates the elements of new operations strategy and their interdependences are proposed. This is just a nascent step toward the understanding of emerging operations management pattern. In the future, more work is required to refine and operationalize the constructs proposed

here as the basis of empirical research to further investigate and test the interrelationships among key elements of operations strategy as well as their links to performance.

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CBR Based Risk Management for Virtual Organization

Min Huang¹, Fei Xu¹, Xingwei Wang¹, W.H.IP²

¹ Faculty of Information Science and Engineering,
Northeastern University
Shenyang, Liaoning, 110004, P.R.China.

E-mail: mhuang@mail.neu.edu.cn

² Department of Industrial and Systems Engineering
The Hong Kong Polytechnic University
Hung Hom, Kowloon, Hong Kong
E-mail: mfwhip@polyu.edu.hk

Abstract: After researching various factors that influence the management and decisions on risk management of virtual organization, CBR based risk management for virtual organization is proposed in this paper. Relevant theories of fuzzy mathematics are utilized in the process of modifying the corresponding similar cases. Correct application of the new method is demonstrated substantially through instance simulation.

Keywords: Virtual Organization Management, risk management, case-based reasoning.

I. Introduction

Virtual Organization emerges recently as a new organization mode of enterprises. This mode has the properties of forming an interim economy of unified command of all enterprises of new product. It helps the enterprises to catch market opportunity and respond rapidly to certain market demand. Simultaneously, studies on strategies of risk management of virtual organization become popular. Successful virtual organization depends a lot on mutual cooperation and communication among enterprises of each partner, which increases greatly the number of factors affecting the risk management of enterprises. Of course, potential risk factors step up quickly as the institutional framework of the enterprises grows and the organization of virtual organizations becomes more complicated. The traditional risk management that works on the basis of regular procedures cannot cope with the new situation. Now, the new method Case-Based Reasoning (CBR) has evaded the bottleneck and solves the problem directly by making use of all existing case experiences for references. It offers an innovative direction in administrative decision of risk management.

II. Problem Description

In order to perform the enterprise's risk management harmoniously, scientific procedures are employed. The complete successive courses of risk management are risk identification, risk assessment, risk evaluation,

corresponding measure and effective risk control based on the risk evaluation, and appropriate handling of unfavorable consequence caused by the risk. In the first process of risk identification, the enterprise's overall goal and sub-goals that have to be accomplished for successful overall target should be clarified. That leads to the necessity of detecting out all risk factors that hinder the achievements of the goals, analyzing the influences of the risk factors, and identifying the existing risks of the enterprise [1]. It is then followed by the implementation of the corresponding measures on effective risk control after assessment and evaluation of the enterprise's risk. Thus the complete process of risk management is finished [2,3].

However, with constantly increasing potential factors that affect an enterprise's risk, the feasibility of the above-mentioned risk management has been queried due to its limitation to analyze and evaluation all risk factors. This paper suggests a new management decision method – CBR based risk management for virtual organization. In this method, every previous case of risk management is regarded as a study case. Through analyzing and comparing the data that correlate with risk factors, a case that is most similar to the present case of risk management is chosen.

Then the chosen case has to be modified under the risk control measures so that it can be utilized for the present one[4].

III. Case-Based Reasoning

The theory behind CBR comes from cognitive science, which states that mankind can retain and memorize information they have perceived. This retained information can be retrieved when similar scenarios appear and are lessons and references for problem solving. The basic thought of CBR is to imitate this human mode of thinking. It deals with present problem by directly retrieving the accumulated experiences and knowledge. Under the enlightenment of cognitive science, Roger Shank of American Yale University proposed the cognitive model and outlines of CBR theory for the first time in 1982, and began to work on the research and application of the field in artificial intelligence [5].

A working course of CBR system is shown in Fig. 1, It includes main steps like case representation, case retrieve, case organization, case revise, case reuse, case retain.

Existing research shows that the CBR is a kind of incremental type of problem-solving method. With the increase of cases and accumulation of experiences, ability of the system in solving problem is increasing constantly. Meanwhile, the continuous development in the technology of computer and artificial intelligence theory impels this method to maturity.

IV. Design of Case-Based Reasoning

Some key technologies that determine the efficacy of the CBR system are included when the system is applied. At present, these are the technologies that develop from the system, like the representation of the case, organization of case retain, retrieve of cases, and strategies of case revision. How to give a rational representation to the case is not a problem. Different ways of representation are designed for cases of different applicable areas. The main reference factors of the representation are integrity, rationality and good expansion performance. An effective case representation usually includes three parts of content: reason or background of the case, its characteristic details, solution and result. The multi-knowledge representation in the field of artificial intelligence is one of the usable examples. More ways of representation that gears at different areas are

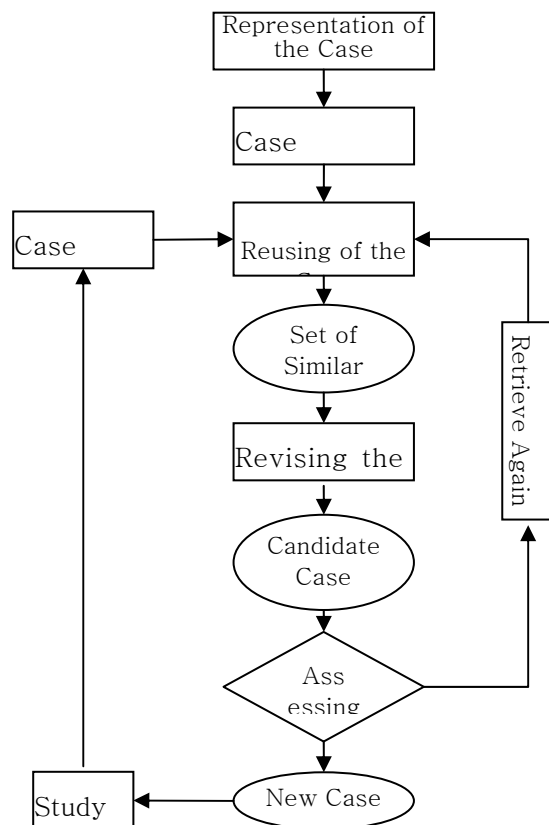


Fig. 1. The flow chart of the CBR System

available as a result of the rapid development in information technology.

Usually the CBR system uses a special case library to retain the cases. With the ever-increasing cases, it is not enough to rely only on good search algorithms to perform case retrieve. The organization and memory structure of the case become a basic problem. It concerns with search speed and successful case search. Nowadays, most CBR systems adopt either dynamic store models or the memory model based on semantic network.

Case retrieve and matching are the keys of the CBR system. Its main purpose is to search out the best case from the cases store according to the definition and description of the new problem and becomes the guideline for solving the new problem. Result of the case search determines the quality of the whole system directly. Nowadays, the commonly used tactics of case search are proximal tactics, derived tactics, knowledge-lead tactics, and template-search tactics.

Case revision is another important step. Its main job is to make appropriate revising and adjusting of the chosen similar case so that it is more applicable for the present situation. But due to diversities of different situations, there is no common tactics for case revision. Real problem has to be solved by concrete analysis. The focus of this paper is to provide guidance on tactics of case modification in risk management of virtual enterprises, utilizing theories in fuzzy mathematics and optimal algorithms. The concrete procedures are:

1) An evaluation performance for the enterprise's risk control tactics has to be listed. It includes data on the frequency of utilization of risk measure, risk expenses, occurrence frequency of the risk, and risk loss. Efficacy of the risk control measures is reflected by its occurrence frequency and the loss. Of course, when it comes to actual application, managers can add other meaningful and measurable performances according to their experience.

2) Statistical analysis on each risk control measure of the chosen case has to be done. Frequency of utilization of the risk measures, occurrence frequency of the risk, and risk loss are calculated. Usually, expenses on risk control measures are known and the risks of the corresponding solutions of each measure are fixed too.

3) Fuzzy intervals are assigned to each measurable performance according to experiences. Usually risk manager inclines to choose control measures of high frequency utilization, low consumed expenses, low occurrence frequency and small loss. Therefore a decision maker needs to define the membership degree of four performance as $A_i(x)$, $i = 1, 2, 3, 4$, to four fuzzy intervals: {Frequency of utilization of risk measure is high}, {Measure expense of the risk is low}, {Occurrence frequency of the risk is low}, {Risk loss is small}.

4) Manager, based on their experiences, establish the weight value w_i for each performance in order to reflect the partiality.

Here, $\sum \omega_i = 1, i = 1, 2, 3, 4$.

5) To get an appraisal result of each risk control measure, the assumed weight values and the calculated membership degree are worked on with the weighted sum by the formula

$$\sum_{i=1}^4 \omega_i A_i(x)$$

6) Usually, an enterprise's risk management is constrained by the expenses of the risk measures. At this moment, not every risk is controllable. Therefore, under the condition of expense constraint, the best combination of risk control measure is selected. This is a typical kind of 0-1-knapsack problem. The method of optimizing can be applied to obtain the final combination of control measures.

V. Simulation Analysis

About 5,800 cases are stocked in the case library of the CBR system as emulation cases. Each case mainly includes contents of three parts. The first part lists 30 attributes that are ascribed to the characteristics of cases which are the data index that are related to the potential risk factors of the enterprise. Through comparison among these characteristic attributes, the case that is most similar to the present case is chosen as guidelines for decision-making. The second part is 8 attributes ascribed to risk control measure, with recorded

solutions adopted for the cases. The last part is 10 slots for recording the risks that have occurred and the subsequent loss in each course of risk management. These data reflect the efficacy of the adopted combination of risk control tactics.

As for the tactics of case retrieve, formula (1) is applied to choose a similar case:

$$\text{sim}(c_i, c_r) = \sum_{j=1}^n \varpi_j \times \frac{|c_i^j - c_r^j|}{c_i^j} \quad (1)$$

Among them, c_i and c_r express cases i and r respectively. ϖ_j shows the weight of the j th attribute. The degree of resemblance between the present case and the case in the case store is calculated through formula (1). A threshold value δ is the established. The degree of resemblance that is lower than δ will be elected and will be regarded as a guideline for present decision making.

Then the following modification method is carried out in order to confirm which risk control measure should be taken in the new case. The chosen case is examined under statistical analysis to confirm the following: frequency of utilization of the risk measure, measure expenses, occurrence frequency of the risk, and the corresponding risk loss. Usually, expenses of each risk control measure do not change. Statistical result is shown in table 1.

Table 1. Statistics of Cases

Control measure of the Risk	Measure 1	Measure 2	Measure 3	Measure 4	Measure 5	Measure 6	Measure 7	Measure 8
Frequency of utilization of the measure	0.51	0.52	0.5	0.44	0.47	0.46	0.43	0.49
Measure expenses	5	3.7	2.5	1.7	1.9	0.7	2	3
Risk	Risk 1	Risk 2	Risk 3	Risk 4	Risk 5	Risk 6	Risk 7	Risk 8
Occurrence frequency of the risk	0.52	0.45	0.41	0.47	0.5	0.48	0.52	0.51
Risk loss	2.9	3.28	2.1	1.8	8.9	6.71	2.93	7.56

As shown in Table 1, measures 7 and 8 are effective for two and three kinds of risks respectively. Other risk control measures address to only one kind of risk. In order to appraise each control measure of risk, a fuzzy set is formed to calculate the membership degree of the statistical results in Table 1. It includes the frequency of utilization of the measure, measure expenses, occurrence frequency of the corresponding risk and risk loss. In the fuzzy sets, only the

four significant elements are taken: frequency of utilization of measure is high, measure expenses are low, occurrence frequency of the risk is low and risk loss is small. Table 2 illustrates the membership functions.

Here, the trapezoid membership functions are chosen. Of course, other types can be selected according to the concrete problem. From the definition of the fuzzy set in Table 2, the membership degree of the fuzzy sets can be

calculated from the statistical data of Table 1. The result is displayed in Table 3.

Then, weight values are assigned to each elements of the set according to the different degree of emphasis. The four

elements are: frequency of utilization of the measure, measure expenses, occurrence frequency of the risk and risk loss. The maximum value to each element is 1 and they are illustrated in Table 4.

Table 2. The Membership Function of the Fuzzy Sets

Fuzzy set	Membership function
Frequency of utilization of measure is high	$A(x) = \begin{cases} 0 & x < 0.2 \\ \frac{x-0.2}{0.4} & 0.2 \leq x \leq 0.6 \\ 1 & 0.6 < x \end{cases}$
Measure expenses are low	$A(x) = \begin{cases} 0 & x < 2 \\ \frac{6-x}{4} & 2 \leq x \leq 6 \\ 1 & 6 < x \end{cases}$
Occurrence frequency of the risk is low	$A(x) = \begin{cases} 0 & x < 0.3 \\ \frac{0.5-x}{0.2} & 0.3 \leq x \leq 0.5 \\ 1 & 0.5 < x \end{cases}$
Risk loss is small	$A(x) = \begin{cases} 0 & x < 3 \\ \frac{9-x}{6} & 3 \leq x \leq 9 \\ 1 & 9 < x \end{cases}$

Through calculations of weighted sum on the data in Table 3 and 4, appraisals on each risk control measures are obtained and shown in Table 5. Here comes a typical solution of 0-1-knapsack problem. The best combination of risk control measure has to be selected under the constraints that the

measure expenses should not exceed the expenses of the new case, which is 9. {Measure 4, Measure 6, Measure 7, Measure 8} should be the best combination since it has achieved the goal of highest control efficacy. It is the solution of the new case.

Table 3. The Membership Degree of Statistical Data

Control measure of the risk	Measure 1	Measure 2	Measure 3	Measure 4	Measure 5	Measure 6	Measure 7	Measure 8
Frequency of utilization of measure (high)	0.76	0.79	0.75	0.6	0.67	0.66	0.58	0.72
Measure expenses (low)	0.25	0.575	0.875	1	1	1	1	0.75
Risk	Risk 1	Risk 2	Risk 3	Risk 4	Risk 5	Risk 6	Risk 7	Risk 8
Occurrence frequency of the risk (low)	0	0.27	0.45	0.13	0	0.11	0	0
Risk loss (small)	1	0.95	1	1	0.015	0.38	1	0.239

Table 4. Appraisal Weight Value of Each Performance

Control measure of the risk	Measure 1	Measure 2	Measure 3	Measure 4	Measure 5	Measure 6	Measure 7	Measure 8
Frequency of utilization of measure (high)	0.3	0.2	0.58	0.39	0.45	0.3	0.5	0.4
Measure expenses	0.3	0.3	0.22	0.17	0.25	0.2	0.1	0.05

(low)											
Risk	Risk 1	Risk 2	Risk 3	Risk 4	Risk 5	Risk 6	Risk 7	Risk 8	Risk 1	Risk 9	Risk 10
Occurrence frequency of the risk (low)	0.1	0.1	0.1	0.21	0.1	0.2	0.1	0.1	0.1	0.1	0.05
Risk loss (small)	0.3	0.4	0.1	0.23	0.2	0.3	0.1	0.1	0.1	0.1	0.5

Table 5. Appraisal Results of Risk Control Measures

Control measure of the risk	1	2	3	4	5	6	7	8
Appraisal result	0.66	0.564	0.54	0.72	0.49	0.7	0.82	0.717
Measure expenses	5	3.7	2.5	1.7	1.9	0.7	2	3

The ten new cases, being chosen according to the above case selection and strategy modification, are tested. The final comparison between the derived risk control measure and the pragmatic risk control measure are listed in Table 6.

Moreover, the unanimous rates of the two combinations – measures of pragmatic case and measures based on CBR are statistically calculated. The average of unanimous rate of the ten cases is 72%.

Table 6. Comparison of Solutions

Case	Combination of pragmatic risk control measures	Combination of derived risk control measures	Unanimous number of measure	Number of actual measure	Unanimous rate
1	1, 6, 7, 8	4, 5, 7, 8	2	4	50%
2	2, 5, 6, 7, 8	1, 4, 6, 7	2	5	40%
3	1, 4, 5, 6, 7	1, 3, 4, 5, 6	4	5	80%
4	2, 3, 4, 8	2, 3, 4, 6, 8	4	4	100%
5	2, 3, 4, 7, 8	2, 3, 5, 6, 8	3	5	60%
6	2, 3, 4, 7, 8	2, 3, 5, 6, 7	3	5	60%
7	4, 5, 7, 8	4, 5, 7, 8	4	4	100%
8	3, 4, 5, 6	2, 3, 4, 6, 8	3	4	75%
9	2, 4, 5, 6, 8	4, 5, 6, 8	4	5	80%
10	3, 4, 5, 6	2, 3, 4, 6, 8	3	4	75%

VI. Conclusions

This article has proposed a CBR-based management decision method for virtual organization risk management. It uses the knowledge of fuzzy mathematics for the strategy of case modification, and develops a tactics of revising the case so that it becomes more applicable for the present situation. The new strategy integrates all considerations of the applications of risk control measures and appraisals on its control efficacy, so that the accuracy of getting the appropriate solution is enhanced. The method is elaborated in details through the emulation analysis.

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Minimizing the Sum of Squared Errors in Seasonally-Adjusted, Trend-Enhanced, Exponential-Smoothing Forecasting

Henry C. Co

Technology & Operations Management
California Polytechnic & State University
3801 W. Temple Ave., Pomona, CA 91768
hco@csupomona.edu

Abstract: Every business seeks to correctly anticipate how much of which products it must manufacture, and where to deliver them, to satisfy the requirements of its customers, as well as its own requirements for growth and profitability. Since the forecast of demand is the cornerstone of all other, subsequent planning, errors become very costly very quickly. This paper presents an optimization model for determining the smoothing constants and initial estimates of level, trend, and seasonality indices in Winter's exponential smoothing forecasting model. The objective is to minimize the sum of squared forecast errors. An Excel template is available for download from the author's website. The template has built-in macros to perform all calculations. Instructions on how to use the template are included in the template.

I. Introduction

The forecast of demand is the gateway linking operations with the marketplace. Through that gateway, supply-chain managers hope to see clearly enough to plan (hire, buy, borrow, etc.), the better to reduce wastes, control costs, avoid conflicts, increase revenues and profits. Prior planning avoids fire-fighting, prepares for crises, and decreases the need for slack resources (capacity, inventory, staffing) to deal with unpredictable demand. In short, effective forecasting helps stabilize operations.

Every business seeks to correctly anticipate how much of which products it must manufacture, and where to deliver them, to satisfy the requirements of its customers, as well as its own requirements for growth and profitability. Since the forecast of demand is the cornerstone of all other, subsequent planning, errors become very costly very quickly. Accordingly, companies try hard to influencing the demand for their products, in the hope of exerting at least some control.

Forecasting models differ from one another according to whether they are qualitative or quantitative, simple or sophisticated. Qualitative forecasting methods rely on the subjective judgment and opinions of one or more individuals, about the likely course of future trends, tastes, technical changes, etc. These methods are useful in forecasting demand when there is little or no data to support quantitative methods (e.g., new products, new markets), and where it is believed that past relationships aren't good indication of the

future.

Quantitative forecasting methods, on the other hand, involve some kind of mathematical modeling. They have stringent data requirements – more data points, or numerical data measured in a way that allows meaningful calculations (e.g., using interval or ratio scales.) Time series analysis is a common forecasting technique in supply chain management. As their name suggest, time series analysis deals with time-based series of values of the attribute of interest, such as quantity sold. The method postulates that: (1) the observed series is the combined result of multiple phenomena; (2) the series therefore can be “decomposed” into its constituent components, i.e., level, trend, seasonality and cycle; and (3) the pattern in the past will continue into the future, thereby justifying extrapolation beyond the historical data.

Time series models include, among many others, the method of moving averages, exponential smoothing (e.g., the Winter's Model), Fourier series analysis, Box-Jenkins auto-regressive moving averages (ARIMA), and time series decomposition.

This paper presents an optimization model for determining the smoothing constants and initial estimates of level, trend, and seasonality indices in exponential smoothing forecasting. The objective is to minimize the sum of squared forecast errors. An Excel template is available for download at www.csupomona.edu/~hco/ManagementScience/00-Winters.xls. The template has built-in macros to perform all calculations. Instructions on how to use the template are included in the template.

II. The Winter's Model

The Winter's model is a seasonally-adjusted, trend-enhanced, exponential-smoothing forecasting model. Seasonally-adjusted trended forecasting uses historical data to derive a “base value L_t ,” a “trend value T_t ,” and a set of seasonal indices $R_1, R_2 \dots R_m$. Here m = number of periods that make up a complete seasonal pattern. For example, if we are dealing with monthly forecasts, then $m = 12$ months/year.

The demand forecast for period $t+p$ is $F_{t+p} = R_{t-m+p} [L_t + (p)T_t]$, for $p = 1, 2, \dots P$. P is the length of the forecasting horizon. R_{t-m+p} is the corresponding seasonal index estimated from the preceding year, L_t is the level of demand estimated at period t , and T_t is the trend component of demand estimated at period t .

For an average period, the seasonal index = 1. The index is greater than 1 if the demand for the period is above

average. On the other hand, an index less than 1 means that the demand for the period is lower than average.

To make seasonally-adjusted trended forecasts, we first have to find a way to derive the “base value L_t ,” the “trend value T_t ,” and the set of seasonal indices R . Then using the latest “base value,” “trend value,” and “seasonal indices” to generate our forecasts. For example, the forecast for month 1 ($t = 1$) is

$$F_1 = R_{-11} (L_0 + T_0)$$

Note that R_{-11} is the seasonal index estimate at $t = m-1 = 12-1 = -11$. L_0 and T_0 are the level and trend components estimates at $t = 0$ (the preceding month).

The Winter’s model consists of three revision equations, each equation for each of the three components of the time series:

$$\text{Base value: } \alpha \left(\frac{A_t}{R_{-11}} \right) + (1-\alpha)(L_0 + T_0)$$

$$\text{Seasonal index: } \gamma \left(\frac{A_t}{L_t} \right) + (1-\gamma)(R_{-11}) \quad , \text{ and}$$

$$\text{Trend component: } \beta (SA_t - SA_0) + (1-\beta)(T_0)$$

$0 \leq \alpha, \beta, \gamma \leq 1$ are the smoothing constants for the level, trend, and seasonality components of the time series.

In the following section, we will demonstrate the method of seasonally-adjusted trended forecasting. The process consists of the following steps:

1. Enter historical demand data.
2. Assume values of the base, the trend, the seasonal indices, and the smoothing constants.
3. Enter the revision and forecasting equation for the initial period. Copy and paste all the way to the row where the last demand data is.

4. Compute some measure of forecast errors.

5. Use Excel’s Solver tool to minimize the forecast error, by changing our initial assumptions about the base value, the trend value, the seasonal indices, and the smoothing constants.

Use the latest “base value,” “trend value,” and “seasonal indices” to generate our forecasts.

III. Optimization Model

Supposed we have collected 60 months of data on demand for air conditioners. We want to forecast the demand for the next 12 months:

	A	B	C
1			
2		Data Range =	60
3			
4			Smoothing
5			Constants
6		$\alpha =$	0.200
7		$\beta =$	0.200
8		$\gamma =$	0.200
9			
10		Demand	
11		1,037	
12		1,070	
13		1,116	
14		1,173	
15		1,337	
16		1,369	
17		1,285	
18		1,438	
19		1,382	
20		1,248	
21		1,254	
22		1,170	
23		1,216	
24		1,390	
25		1,498	
26		1,469	
27		1,600	
28		1,800	
29		1,812	
30		1,769	
31		1,636	
32		1,591	

1. The first step is to decide the values of the smoothing constants α , β , and γ . Additionally, we need the initial values of the level, trend and seasonal components. Let us arbitrarily assume $\alpha = \beta = \gamma = 0.2$. We make reasonable assumptions about the initial values of the level, trend and seasonal components. This is shown below:

	A	B	C	D	E
1					
2		Data Range =	60		
3					
4			Smoothing		
5			Constants		
6		$\alpha =$	0.200		
7		$\beta =$	0.200		
8		$\gamma =$	0.200		
9					
10		Demand	Level	Trend	Season Idx
11					1.000
12					1.000
13					1.000
14					1.000
15					1.000
16					1.000
17					1.000
18					1.000
19					1.000
20					1.000
21					1.000
22			985	52	1.000
23		1,037			
24		1,070			
25		1,116			
26		1,173			
27		1,337			
28		1,369			
29		1,285			
30		1,438			
31		1,382			
32		1,248			

Notice that we have inserted 12 rows after row 10. We need 12 rows for the 12 seasonal indices (Column E). In the worksheet above, we assumed that all seasonal indexes are

equal to 1. The level component (cell C22) is 985 and the trend component (cell D22) is 52. Don't worry about making bad assumptions. Later, we will use an Excel tool called **Solver** to change them.

2. Write the Winter's Equations for the first period (i.e., for $t=1$). These are:

$$\alpha \left(\frac{A_t}{R_{t-m}} \right) + (1 - \alpha)(L_{t-1} + T_{t-1})$$

$$\beta(L_t - L_{t-1}) + (1 - \beta)(T_{t-1})$$

$$\gamma \left(\frac{A_t}{L_t} \right) + (1 - \gamma) (R_{t-m})$$

The corresponding Excel formulae are:

$$C23 = \$C\$6 * (B23 / E11) + (1 - \$C\$6) * (C22 + D22)$$

D23=\$C\$7*(C23-C22)+(1-\$C\$7)*D22, and

$$E23 = \$C\$8 * (B23 / C23) + (1 - \$C\$8) * E11$$

The forecast for the first period is $F_{23} = (C_{22} + D_{22}) * E_{11}$, i.e., the sum of the level and trend component, multiplied by the first seasonal index.

The forecast error for the first period is $G_{23}=B_{23}-F_{23}$

3. Copy all formulae and paste all the way down to the last row of demand (row 82).:

A	B	C	D	E	F	G
1						
2	Data Range =	60				
3						
4		Smoothing				
5		Constants				
6	α =	0.200				
7	β =	0.200				
8	γ =	0.200				
9						
10	Demand	Level	Trend	Season Idx	Forecast	Error
11				1.000		
12				1.000		
13				1.000		
14				1.000		
15				1.000		
16				1.000		
17				1.000		
18				1.000		
19				1.000		
20				1.000		
21				1.000		
22				1.000		
23	1,037	1,037	52	1.000	1,037	0
24	1,070	1,085	51	0.997	1,089	-19
25	1,116	1,132	50	0.997	1,136	-20
26	1,173	1,181	50	0.999	1,182	-9
27	1,337	1,252	54	1.014	1,230	107
28	1,369	1,319	57	1.008	1,306	63
29	1,285	1,357	53	0.989	1,375	-90
30	1,438	1,416	54	1.003	1,410	28
31	1,382	1,452	51	0.990	1,470	-88
32	1,248	1,452	40	0.972	1,503	-255

4. Enter formulae for sum of squared error and the average (Mean) error. Also, enter the formula for I4=AVERAGE(F11:F22); I4 is the average of the first 12 month's seasonal indices.

L24==SUMSQ(G23:G82)

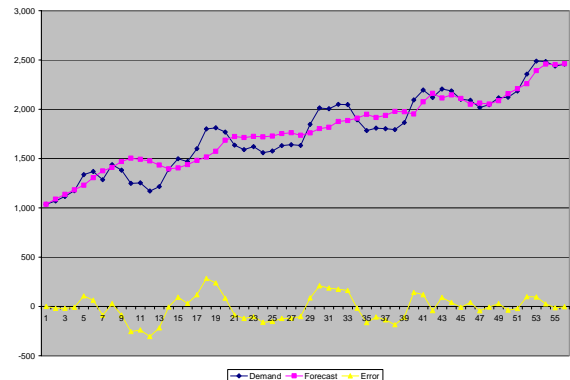
L25=AVERAGE(G23:G82), and

L26=AVERAGE(E11:E22).

	L24				=SUMSQ(\$G\$23:INDEX(G:G,\$C\$2+22))	
	H	I	J	K	L	M
22						
23						
24						
25						
26						

The sum of squared error is 917,831. The mean squared error (MSE) = $917.831/59 = 15556$. Figure 1 below shows a


graph of the actual and forecasted demand:




5. In step 1, we assumed, quite arbitrarily, the values of the smoothing constants, and the initial values of the level, the trend, and seasonal components of the time series. In this step, we will use a tool in Excel called Solver, to minimize the sum of squared forecast errors, by changing these assumed values.

Click Tools on the top of the Excel worksheet. From the Tools menu, select Solver, and the following Solver Parameter appears:

Solver Parameters

Set Target Cell: 

To: ☒ Max ☐ Min ☐ Value of:

By Changing Cells: 

Subject to the Constraints:

Options

☒ Make Variable Cells Non-Negative

Solving Method

GRG Nonlinear Engine

Buttons: Solve, Close, Guess, Options, Add, Change, Delete, Reset All, Help

Starting from the top, enter L24 in the 'Set Target Cell' box. L24 is the sum of squared forecast errors. Next, click on the Min button to tell Solver that you want to minimize L24.

In the 'By Changing Box,' enter the cells where you find the values of the smoothing constants, and the initial values of the level, the trend, and seasonal components of the time series. These are: C6:C8 for the smoothing constants, C22:D22 for the level and trend components, and E11:E22 for the seasonal indices.

Solver Parameters

Set Target Cell:

Equal To: ☐ Max ☒ Min ☐ Value of:

By Changing Cells:

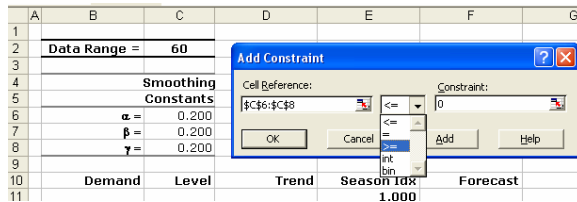
Subject to the Constraints:

Solve **Close** **Options** **Reset All** **Help**

Add **Change** **Delete**

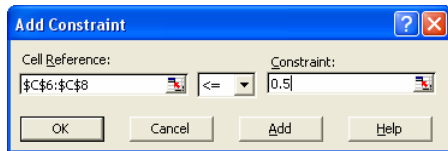
Note that Excel automatically add the '\$' sign to the cell references above.

Now, click Add to introduce some constraints. To make sure that the smoothing constants are non-negative, enter C6:C8 in the Cell Reference box, choose the greater-than-or-equal-to symbol \geq , and enter 0 in the constant box. This is shown below:



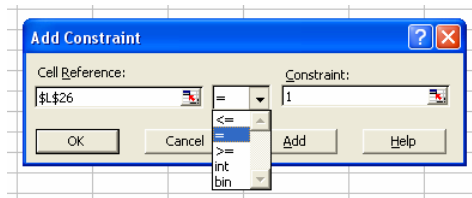
Note that instead of specifying 0 as the lower-bound for the smoothing constant, you may want to specify a small constant, say 0.01.

Similarly, we may want to specify an upper-limit for the values of the smoothing constant. Click Add to introduce another constraint:

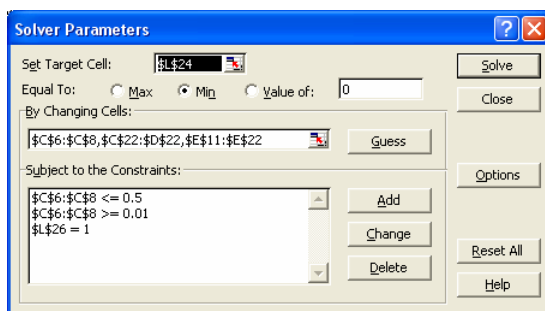


Here, we specify that the smoothing constants must not exceed 0.5.

Finally, add a constraint to make sure that the average of the seasonal indices = 1. This is shown below:



The completed Solver Parameter menu is shown below:



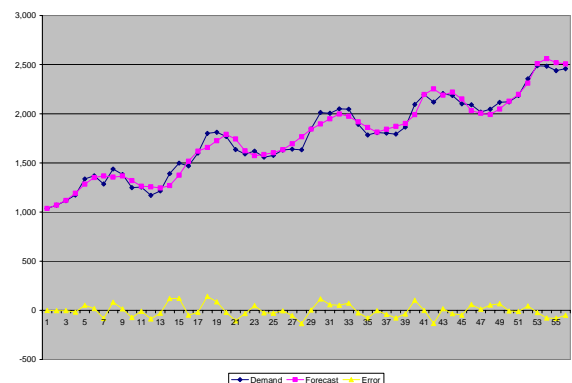
Here the lower-and-upper bound for the smoothing constants have been set at 0.01 and 0.5, respectively. Click 'Solve' to minimize the sum of squared forecast errors.

6. Optimized Worksheet

	A	B	C	D	E
1					
2		Data Range =	60		
3					
4			Smoothing		
5			Constants		
6		α =	0.446		
7		β =	0.010		
8		γ =	0.010		
9					
10		Demand	Level	Trend	Season Idx
11					0.927
12					0.939
13					0.961
14					1.004
15					1.070
16					1.084
17					1.071
18					1.071
19					1.033
20					0.976
21					0.940
22			1,095	23	0.922

Summary Statistics	
Sum of Squared Errors	233,257
Mean Error	-1
Average of Season Idx	1.000
Components of the Time Series	
The Level Component	2,456.2
The Trend Component	22.9
The Season Components	
Period	
1	0.927
2	0.939
3	0.961
4	1.004
5	1.070
6	1.085
7	1.071
8	1.071
9	1.033
10	0.976
11	0.940
12	0.922

The sum of squared error is 233,257. The MSE = $233,257/59 = 3954$. Using Solver, we were able to reduce the MSE by 75%. Figure 2 below shows a graph of the actual and forecasted demand:



The components of the time series shown here are the latest "base value," "trend value," and "seasonal indices" to

generate our forecasts. These values can be found at the bottom of the spreadsheet.

The forecasts are:

Jan	$[2,456.4 + (1) * (22.9)] * 0.927 =$	995
Feb	$[2,456.4 + (2) * (22.9)] * 0.939 =$	1.023
Mar	$[2,456.4 + (3) * (22.9)] * 0.965 =$	1.065
Apr	$[2,456.4 + (4) * (22.9)] * 1.004 =$	1.145
May	$[2,456.4 + (5) * (22.9)] * 1.070 =$	1.303
Jun	$[2,456.4 + (6) * (22.9)] * 1.085 =$	1.215
Jul	$[2,456.4 + (7) * (22.9)] * 1.071 =$	1.239
Aug	$[2,456.4 + (8) * (22.9)] * 1.071 =$	1.225
Sep	$[2,456.4 + (9) * (22.9)] * 1.033 =$	1.089
Oct	$[2,456.4 + (10) * (22.9)] * 0.976 =$	1.006
Nov	$[2,456.4 + (11) * (22.9)] * 0.940 =$	967
Dec	$[2,456.4 + (12) * (22.9)] * 0.922 =$	928

IV. Final Note

Using Solver, we were able to reduce the MSE by 75%. In the illustration above, we allowed Solver to change the smoothing constants, and the initial values of the level, the trend, and seasonal components. Sometimes, we are better off using our judgment to decide on the appropriate values of the smoothing constants.

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Trends in the Delivery and Utilization of Enterprise ICT

Jiri Vorisek

Department of IT, University of Economics Prague
W. Churchill Sq. 4, 130 67 Prague 3, Czech Republic
Tel: +420 603 414848

E-mail: vorisek@vse.cz

Abstract: In this decade, we can expect changes in enterprise information systems that are even more dramatic than the changes in the last decade of the previous century. The changes will have an impact on end-user organisations as well as on suppliers of ICT products and services. They will also influence the number of graduates in ICT disciplines that will be needed and the type of qualification they will require. The aim of this article is to shed light on these changes and suggest how end-user organisations, ICT supplier organisations and universities can prepare for them.

I. Introduction

For the past two years G.Feuerlicht and I [6] [7] have been analysing the latest developments in information services worldwide. From this analysis we have concluded that the prevailing mode for supplying applications to users in the second half of this decade will be, with a high probability, outsourcing. In particular, one of the outsourcing variants "software-as-a-service" or ASP (Application Service Providing), is very likely to become dominant. Increasingly greater utilisation of externally supplied information services will influence the market in IS/ICT and the management of enterprise IS/ICT. During this year the author has carried out further interviews with leading Czech IS/ICT professionals - Martin Bednár, SAP ČR, Radim Hradílek, IBM ČR, Jan Kameníček, HP ČR, Jiří Polák, Deloitte&Touche. The main conclusion from these discussions and from the analysis is the prediction that in this decade we can anticipate even more dramatic changes than in the last decade of the previous century. These changes will affect both user organisations and organisations supplying IS/ICT products and services. The aim of this article is to shed light on these changes and indicate how the user and supplier organisations can prepare for them.

II. Significant trends in the utilisation of IS/ICT by enterprises

This section summarises the trends which in the opinion of the author will have a substantial influence on future utilisation of IS/ICT by user organisations and, consequently, on the composition of IS/ICT market.

Strategic importance of ICT has not ceased

Less than two years ago Nicolas Carr published a provocative article in the Harvard Business Review "IT Doesn't Matter" [1] in which he declared that ICT is a commodity accessible to everyone. He compared ICT with railways and electricity and argued that it is no longer possible to use ICT to gain a strategic advantage against the competition.

Since this publication there have been many heated discussions on this theme in the Czech Republic and worldwide. Some debaters, including the author of this article, agree with much of what Carr wrote, but point out he makes a mistake of judging the influence and significance of ICT in isolation from entrepreneurial activities, business processes and company culture. The main difference between ICT and railways or electricity is that ICT has much greater influence on the business processes and the approach to management and production. Consequently, what can give a company (or a country) competitive advantage is not just ICT but appropriate integration of ICT with its entrepreneurial activities, its business processes and its culture. When this integration has a unique character that results in a product/service with higher utility value or lower cost then it will give the company a strategic advantage.

M.Bednár in an interview about the importance of ICT expressed it like this: "The deployment of ICT these days can be one of two types of applications:

- *applications that support business processes (back office, logistics, CRM etc.),*
- *applications that implement business processes, i.e. where the process exists only in an electronic form (electronic banking, mobile telephony, digital airline ticket etc.).*

For the first type of applications, it is possible to gain competitive advantage by combining ICT with an exceptional company culture and knowledge. This combination is unique for each company and enables the company to function effectively with flexibility and right priorities. The understanding of the importance and the potential of ICT is strategic because without ICT the assets of the company such as knowledge, culture and motivation will not be utilised. For the second type of application we have a product, its attributes and timely deployment to the marketplace – whoever gets there first gains a vital competitive advantage."

In support of the above claims, we can look at the success of Wal-Mart. In the Czech Republic, we can give an example published on www.ihned.cz in 2004: "The

company Czech Courier, operating a courier service eKurýr (www.ekuryr.cz) on the Czech and Slovak Internet, gained the representation of the international courier Sky Net Worldwide Express for the Czech Republic and Slovakia. Czech Courier was founded in 1999 to focus on express delivery of consignments with high added value. This added value lies principally in a unique electronic system eKurýr. As a result the deployment of this system the company has become a pioneer in utilising the Internet as a new commercial platform for courier services."

For an organisation, not every new technology is important, but to miss some utilisation of the available technology can be fatal. For example, those suppliers of accommodation services who do not offer their services on the worldwide web are losing clients who are using only this communication channel. This could be a substantial part of the potential clientele.

The often accepted assertion, that using standard technology that is accessible to everyone (e.g. standard ERP or CRM) it is not possible to gain a strategic advantage, cannot not be right. The reason is that a unique integration of a standard ERP with business processes is very difficult to copy by the competition.

Interesting in this context is the view of J. Kameníček: "ICT still is not a 100% commodity. Hardware, operating systems and office applications have the characteristics of a commodity, but applications such as ERP, CRM and BI do not yet have them. Deployment, customisation and integration of these types of applications is complicated. Good integration of these applications with the business processes can bring a strategic advantage."

Another factor that supports an argument for the strategic importance of ICT is the unremitting growth in the demand for timeliness and quality of information for decision making in the global economy from all levels of management. When it comes to the speed of reaction to important events, e.g. Gartner (2004) claims:

- in 2002 most goals had up to 2 months to be achieved,
- in 2004 it was only 1 month,
- in 2006 it will be 14 days,
- in 2008 it will be 7 days,
- and in 2010, it will be the same day.

It is not really a question of whether this forecast is accurate. The significant trend in the shortening of companies' reaction response time to external events cannot be doubted.

Conclusion number 1:

ICT still has strategic importance but different ways of ensuring this have to be found. Strategic advantage cannot be achieved by just deploying new technology. The prerequisite is a unique and effective integration of ICT with entrepreneurial activities, the company culture and the business processes. Such integration will enable the company to speed up its response to important events, reduce cost and increase

the quality, and help to provide new products or services to customers. Future ICT projects should focus on this type of integration.

Strengthening of the process orientation of an enterprise

In the end of the last century it was becoming clear that a functionally managed enterprise faces difficulties to solve problems (interests of individual departments can clash with organisational goals; an ambiguous, sometimes even an undefined process for customer orders; a difficult to predict time the enterprise will take to respond to important events etc.). The solution to such problems was to adopt process-management in the enterprise as depicted in Figure 1 [22]. With regards to the arguments in previous section, the

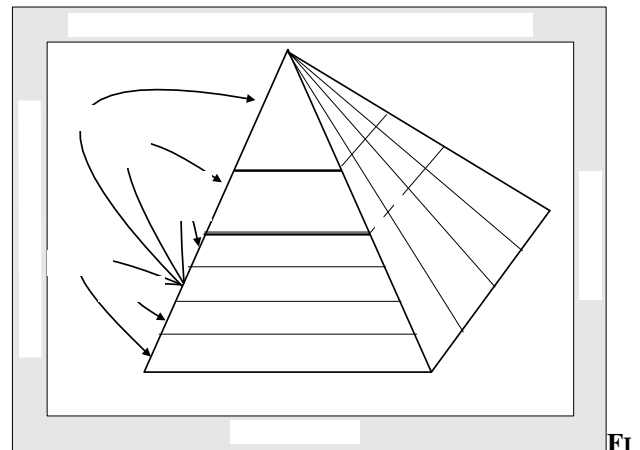


FIGURE 1: A process-managed enterprise

importance of process-management is still growing.

In a process-managed enterprise the key business processes are:

- business strategy formulation and implementation,
- new product/service development,
- production and supply processes definition and optimisation (methods, technological resources, personnel and know-how),
- supply-chain management (from integrating with suppliers to connecting with customers).

The aim of process-managed organisations is to achieve the state of so-called event-managed organisation and an organisation working in real-time. This means that the organisation has active sensors (usually using of IS/ICT) that indicate new events (arrival of an order, time to send VAT returns, production line failure, ...). As soon as the event happens, the process that guarantees the right response is activated. The response of the enterprise should be in real-time, i.e. in time that is optimal from the perspective of the supply chain, external partner, customer and the like.

This trend is affecting even enterprise ICT, i.e. many enterprises are adopting process-management of their own IS/ICT. ITIL and COBIT methods are de facto standards in

this area.

ICT marketplace has responded to the transition to process-management with a relatively wide choice of tools for business process modelling and for optimisation, monitoring and management of live processes. The Organization for the Advancement of Structured Information Standards [14] has been defining standards in this area. The success of process-management depends on a number of critical success factors. The most important of these are:

- change in the thinking of enterprise managers. Process-management requires other types of knowledge and skill compared to the classical functional-management; some managers do not have these and are not able to accept and apply new responsibilities and authority that are required,
- appropriately chosen detail of business process definition and its alignment with the knowledge of the employees undertaking the process [20]. A detailed definition of a process facilitates using less well qualified but well trained employees (consider e.g. workers on car assembly lines). On the down side, it prevents utilisation of employees' creativity and reduces the flexibility of the process (try, for example, to order a schnitzel in McDonalds),
- appropriately chosen process maturity. CMM [3] defines six levels of process maturity. The lowest level is for a non-existent process, the highest describes an optimizing process. However, it is not sensible to plan for the highest level for each process. This would be too expensive for processes that are not vital to the enterprise and happen rarely,
- appropriate utilisation of process methods and standards. When implementing process-management it is a good idea to use methods and standards designed for this - e.g. the above-mentioned ITIL and COBIT. Experience from process-oriented projects shows that it is very dangerous to apply the recommended standards mechanically. Each method must be tailored to the specific condition of the enterprise.

Conclusion number 2:

Enterprise process-management and process-managed ICT are now a necessity. Implementing process-management is a long-term activity that requires specific knowledge and skills, with success depending on specific critical factors.

Management of the relationship between business and ICT using ICT services

How to optimally link business and ICT is a problem that has eluded solution since enterprises first started to use ICT. For over 50 years, computer professionals and end-users have been looking for an optimal way to communicate with one another and for an optimum division of responsibility

for the costs and benefits of ICT projects. It seems like in this area things are looking up thanks to new methods for managing the relationship between business and ICT. These methods utilise the concept of ICT service, described using an SLA (Service Level Agreement), as a basic element on the boundary between the business and ICT. One of these methods - SPSPR - was described in [21]. One benefit of the SPSPR method is in that it defines the content of the communication between end-users and ICT professionals without undue use of technological concepts. Another benefit lies in the clear demarcation of responsibilities of different types of managers (TOP manager, owner of a business process, CIO, owner of an ICT process, manager of an ICT resource) for costs and benefits of ICT.

Similarly, to process-management the management of ICT services has a number of critical success factors. The most important of these are:

- the ability of the owners of business processes to define SLA for ICT requirements,
- the focus of ICT services. ICT services should be derived from the requirements of business processes, not from the interests of enterprise departments. I.e., the ICT services should be focused on improving performance of the enterprise, on bottlenecks in the business processes and on the business continuity. In the case where ICT services are not related to any business processes but only to departments, the requirements for the ICT services are often inappropriate (e.g. the department requires a higher availability of the service than is absolutely necessary) and derived from particular interests of the department and not from enterprise goals.
- The ability of ICT managers to specify and manage ICT infrastructure that facilitates provision of agreed scalable ICT services.

Conclusion number 3:

Management of the relationship between business and ICT using ICT services has proved the best solution to the long-standing problem of communication between business and ICT professionals. However, this requires new knowledge and skill from both sides.

Emphasis on management of the returns on ICT investment

The ICT crisis since the beginning of this decade resulted in increased emphasis on the management of the returns on ICT investment. Progressively managed enterprises no longer invest into ICT without a thorough analysis of the return on investment and refuse to finance long-lasting ICT projects because they are very risky.

More and more TOP managers require that their CIOs ensure that any increase in the investment into ICT correlates with the increase in the turnover and that no projects are started unless an improvement in the performance of the enterprise can be guaranteed. The question is, how can

a CIO fulfil such expectations.

The first requirement needs a scalable ICT infrastructure and scalable ICT processes. When an enterprise operates its information systems on its own ICT infrastructure, scaling up or down may not be a realistic option. An enterprise has to plan its ICT infrastructure for the maximum anticipated required performance and incremental increases and reductions in capacity (e.g. disposing of surplus hardware, software licences and ICT specialists) are often impossible in practice. The solution to this problem is to buy external services; this will be discussed in the next paragraph.

The second requirement - guaranteed improvement in the enterprise performance - cannot be achieved by the ICT department alone. The requirement can be met only by an appropriate distribution of responsibilities of ICT and business managers - e.g. using the above-mentioned SPSPR model. According to this model, the benefits of the commissioned ICT services will be the responsibility of the business process owner. The owner of the business process has to add the cost of each ICT service to other process costs and then evaluate the effectiveness of the process. If the cost of an ICT service is too high, the requirements should be reconsidered (e.g. reducing functionality, the number of users or availability). By contrast, the CIO is responsible for ensuring that the cost of an ICT service is competitive with similar ICT services on the market.

From the perspective of the current trends, the ICT market offers one good and one bad news. The good news is that thanks to the transfer of the development of a number of ICT products to China and India the cost will be coming down, perhaps even faster than the Moore's law would suggest. The bad news is that the requirements for the content, volume and quality of ICT services will be go on increasing, probably even faster than the decrease in the cost of ICT products. The reason for this are the trends mentioned above.

Conclusion number 4:

Well-managed enterprises want to control their ICT costs. The development of ICT has to reflect the growth in the turnover of the enterprise. Preconditions for success in this area are scalable ICT services and a clear allocation of responsibilities for the benefits and costs of ICT between the business and ICT managers.

Purchasing external ICT services instead of purchasing ICT products

The aspiration to concentrate enterprise activities on the core business of the enterprise and the consequent aspiration to outsource support business processes, together with the aspiration to buy scalable ICT services (based on the "pay as you go" principle), lead enterprises in the direction of ICT outsourcing.

In 2004, PMP Research carried out a survey into the scale of ICT outsourcing in end-user organisations. The results of this research show that more than a fifth of end-

user organisations spend more than half of their ICT budget on outsourcing and almost two thirds of organisations anticipate same or greater expenditure on outsourcing services.

Deciding about what to own and what to buy as an external services is not easy. An enterprise should have a sourcing strategy and use it to make such decisions. The development of a sourcing strategy as well as its use for decision-making is a complex process since a large number of variants with different critical success factors [6] needs to be considered. Some possible variants are:

- 1) BPO (Business Process Outsourcing), where the whole business support process is removed - e.g. accounting or transport - including ICT resources and their support,
- 2) total outsourcing of IS/ICT, where a selected external partner takes over all the ICT services, processes and resources,
- 3) partial outsourcing of ICT, where some ICT services, processes and resources are removed. Partial outsourcing has a large number of variants:
 - a) "classical ASP, where an external provider operates an application, used by many customers (companies) on its own infrastructure. An example is the service of Sales Force that currently provides CRM functionality for more than 100,000 users,
 - b) ASP operates single-customer applications (e.g. SAP R/3) on its own ICT infrastructure, but the infrastructure is shared by the applications. An example of such an ASP is the company Corio,
 - c) as b), but each customer has its own dedicated infrastructure,
 - d) the customer operates an application on its own infrastructure but the administration of the infrastructure is outsourced,
 - e) ICT infrastructure is outsourced by the customer operates and administers its own applications,
 - f) external administration of end-user workstations,
 - g) external operation of a Call centre,
 - h) etc.
- 4) outsourcing the development of an application.

The latest analysis [23] and predictions [2] show that the prevailing forms of outsourcing will be those described in 1), 2) and 3a) above.

For example, according to R.Hradílek, IBM is assuming that most of their customers (companies) will move to a complete outsourcing of their IS/ICT by 2010.

Just like in the case of the previous trends, effective utilisation of outsourcing depends on a number of critical success factors:

- choosing an appropriate variant of outsourcing,

- choosing an appropriate granularity of ICT services. At one extreme an ICT service can be all of the functionality of an ERP system, at the other extreme a service could be one transaction (e.g. ordering an airline ticket using a Web service),
- monitoring of ICT services to be able to carry out a detailed analysis of the cost of the services, processes and resources. Without good monitoring it is not possible to find out what is a better value - internal or external supply,
- quality of decision-making when deciding whether to outsource or not depends on the quality of information about the ICT market (services on offer) and on the quality of the sourcing strategy.

Another critical success factor in outsourcing has been proposed by M.Bednár: "An outsourcing contract can significantly complicate enterprise restructuring and attempts an ICT innovation. When an enterprise disposes of all of its ICT expertise, it can find itself in precarious position when it comes to the development in ICT.

Conclusion number 5:

It is highly probable that by the end of this decade outsourcing and particularly one of its forms - ASP - will be the prevailing means of acquiring ICT services.

Impact of the trends on end-user organisations

If the above-mentioned trends are realised, we can anticipate the following impact on end-user organisations:

- More and more decision about utilising ICT will be made by the owners of business processes and as a part of strategic management. This will require changes in the qualification required by these types of managers. Managers who understand how to use ICT to develop new product or service, or how to gain new customers, will become indispensable members of the top management team in most enterprises [17].
- Employees of an ICT department will have to know how to better demonstrate the value of ICT for the business and offer new ways of utilising ICT by the business. Wal-Mart is a good example. According to their CIO J.Carey the members of his team sit on all the top discussions about the company's strategy, as well as discussions about changes in the marketing and commercial activities.
- Because of outsourcing, the number of technologically oriented specialists (e.g. programmers, ICT administrators) in companies will decrease. However, the number of employees involved with the relationship between the business and ICT services (requirements definition for ICT, SLA specification, monitoring of the supply of services and the like) will increase. Not all of these employees will be working in the ICT department. In 2004 Gartner predicted that in the North American and European companies the fraction of employees

working in ICT will reach 8% in 2006 and in the "ICT driven industries", i.e. organisation such as banking, post, insurance, utilities and retail, it will be as much as 15-20%.

- The integrative and innovative role of ICT departments will grow. This is particularly the case for the "ICT driven industries". This is because ICT processes are not like standard support processes such as accounting or purchasing, they have an immediate impact of the effectiveness on most core business processes.
- The volume of ICT services will be scalable, and ICT costs will correlate with the level enterprise activities and the turnover.

Even though a number of ICT services will be purchased from external suppliers, the number of employees concerned with the utilisation of ICT will not decrease, but the structure of their qualifications will change. An enterprise must preserve the following key expertise:

- how to gain a competitive advantage using ICT, i.e. how to use ICT to create new product/service, gain new customers, speed up the response of the enterprise to external events and reduce process costs. In other words: how to support the business processes with appropriate ICT services - i.e. ICT services that provide appropriate functionality, quality and volume at a competitive cost.
- how to design the overall architecture for ICT services,
- which services, processes and resources should be owned and which should be outsourced,
- selection of the best supplier of an ICT service,
- monitoring and control of the supply of ICT services,
- monitoring of ICT services and measurement of the benefits of ICT for business processes.

III. Impact of the Trends on Supplier Organisations

If the above-mentioned trends are realised, particularly outsourcing of ICT services and stricter monitoring of the relationship between costs and benefits, we can anticipate the following impact on supplier organisation:

- The sale of new software licences to end-user organisations will decrease. The following tables confirm this trend. They were compiled using annual reports of large software houses. It should be noted that while the income from new licences decreased, income from maintenance and related services grew. Haber's research [8] came to the same conclusions. He found that currently 80% of software cost is for maintenance of applications and related activities. The increasing cost of maintenance could be another factor that will

contribute to the greater orientation of end-user organisations on outsourcing of their applications.

Oracle	1999	2000	2001	2002	2003
Licence					
annual growth		20	6	- 25	- 6
as a fraction of the total income	41	43	42	36	34
Support					
annual growth		27	20	8	8
as a fraction of the total income	27	29	33	40	44

PeopleSoft	1999	2000	2001	2002	2003
Licence					
annual growth		46	30	- 18	2
as a fraction of the total income	24	29	30	27	24
Services					
annual growth		5	23	3	22
as a fraction of the total income	74	64	65	72	76

SAP AG	1999	2000	2001	2002	2003
Licence					
annual growth		27%	5%	-11%	-6%
as a fraction of the total income	38%	39%	35%	31%	31%
Maintenance					
annual growth		44%	27%	15%	6%
as a fraction of the total income	23%	27%	29%	33%	37%

Siebel	1999	2000	2001	2002	2003
Licence					
annual growth		118%	- 4%	34%	31%
as a fraction of the total income	62%	61%	51%	43%	36%
Services, Maintenance etc.					
annual growth		126%	44%	- 8%	- 7%
as a fraction of the total income	38%	39%	49%	57%	64%

- Because of the decrease in the sales of new licences and the growth in outsourcing the number of software companies will fall. Those that do not adapt their business to these trends will fail.
- The key commercial article, instead of software and hardware products, will be scalable ICT services on-demand services, software-as-a-service...). Thus the hardware and software products will be "returning" to their makers who will use them to offer services on a large scale. In this context, F.Hoch – vice-president of the Software & Information Industry Association [19] declared "We believe that the software industry, as we know it, is passing away and a new industry is being born". Hamm and Ante [9] declare "Accenture, thanks to BPO, added 2.2 billion dollars to its revenue, 50% more than in the previous year, while IBM achieved an income of 3 billions from outsourcing and related activities, representing an increase of 45%!".

The gradual transition of large suppliers from products to services is illustrated by the following tables:

IBM % revenue	2000	2001	2002	2003	2004
servers	22,68	22,32	20,04	18,72	18,89
PCs	17,83	14,51	13,78	12,97	13,47
HW total	40,51	36,83	33,82	31,68	32,35
SW	14,81	15,58	16,10	16,06	15,68
IT services	38,96	42,08	44,79	47,83	47,99
Financial services	4,07	4,12	3,98	3,17	2,71
others	1,65	1,39	1,31	1,26	1,27

Hamm and Ante [9] have given some interesting facts about IBM: "The change is tangible. The number of employees focused more on the commerce than on pure technology has risen from 3,500 in 2002 to the today's more than 50,000 (in the total of 330,000 worldwide), and this represents a growth of over 10,000 annually. As a part of a painful process, other employees are leaving in their thousands - for example from the administrative and computer maintenance divisions.

With the sale of the loss-making PC manufacturing to the Chinese company Lenovo Group, Palmisano cut off a large part of the company's computer inheritance. At the same time he netted more than a dozen of companies in the area of support for entrepreneurial activities, including Daksh, an Indian customer relationship management company with six thousand employees."

HP % revenue	2000	2001	2002	2003	2004
servers	26,00	25,26	22,33	21,03	20,12
PCs	35,85	33,04	30,23	29,03	30,81
Printers, scanners	22,47	24,01	28,20	30,89	30,28
HW total	84,32	82,31	80,75	80,95	81,22
IT services	14,05	15,84	17,10	16,91	17,24
Financial services	2,00	2,62	2,89	2,63	2,37

SUN Microsystems % revenue	2000	2001	2002	2003	2004
Servers		67,88	59,19	54,60	52,34
Storage		14,39	13,58	13,56	13,42
Products total	85,37	82,27	72,77	68,16	65,76
Support services		11,99	20,31	24,87	26,81
Professional and Knowledge services		5,74	6,92	6,97	7,43

- The concept of a supplied ICT service is changing. It is no longer a question of supplying as much as possible for the highest price without considering the real needs of the customer. The aim of the best suppliers of ICT services will be to understand what the customer and the customer's customers require, and then plan and manage the supply of ICT services accordingly.
- There will be changes in the structure and company culture of supplier companies that respect the fact that supplying ICT services requires a different type of enterprise when compared to enterprises that supply products and licences.

Let us now look at the views of our interviewees on the probable consequences of the trends on end-user and supplier organisations.

M.Bednár: "From the perspective of ERP systems supplier the number of customer users is fundamental. The number of users and the number of dedicated servers are the basic metrics for calculating the cost of software. It therefore does not matter whether the users are supported via an ASP or directly. In both cases, the customer has to pay the cost of the licence. Positive effects can only be the result of quantity discount. Then it is a question of who benefits – is it the customer or ASP? The transformation from buying software up-front to renting it is only the result of financial engineering."

J.Kameníček: "HP – formerly primarily a product company, is increasing its focus on services. The classical ASP is not yet part of the HP's services portfolio, but outsourcing IS/ICT is our fastest growing service segment. Outsourcing services are offered as a part of the "utility computing" concept, i.e. the cost of services is derived from unit costs (per user in a particular category, per server etc.). The customer can thus easily change the volume of the

service as required and pay only for the actual number of users or supported servers in a given month. In the Czech Republic, the transfer to ASP will not happen quickly. The reason is the strong conservatism of customers and the distrust that leads to unwillingness to relinquish control of data and key ICT infrastructure."

J.Polák: "D&T has begun to offer ERP in the form of ASP – from January 2005 we are offering SAP and Peoplesoft in this way. It will be possible to rent individual modules as an application service. However, the difference from EDS and Accenture is that this is not a part of our core business."

R.Hradílek: "Recently, in the Czech Republic, there has been a decline in the demand for strategic and business consulting services, and an increase in the demand for ICT services and outsourcing. IBM has been strengthening its focus on supplying ICT services. We offer these under the label "On-demand Services" and "Managed Services". In the near future large ICT companies, as well as offering ICT services, will be offering other types of services that require ICT (e.g. collecting parking fees and fines, accounting etc.)."

M.Bednár: "I agree that the number of technologically oriented specialists in end-users organisation will fall. However, outsourcing results in new problems for which the customers should be ready."

J.Polák: "The increase in the required number of specialists who integrate business processes with ICT services will not affect just end-user organisations. It will be an opportunity for new consulting firms that specialise in this area. I do not think there will be less demand for developers. I can imagine that there will be several tens of new software houses, each with several tens of programmers. An example of what could happen is as follows: in England, a new company is started that bids for development projects. The actual development will take place in the Czech Republic and the English company will supply the software to the customer. Compared to China or India this form of outsourcing will have the advantage in the knowledge of cultural and legislative conditions in Europe."

J.Kameníček: "I agree that there is a trend in the decrease of ICT specialist in customer companies. However, this will not affect Czech economy in the next few years. Centralisation and remote administration of ICT may make the operation of ICT more effective, but thanks to cheaper labour, there is a significant trend in transferring of many companies from Western Europe to Central and Eastern Europe. These transfers are creating many new work opportunities in ICT so that the number of ICT workers has been increasing, particularly in Prague and other large towns."

M.Bednár: "The reduction in software implementation services is real. However, this is true more for financial and administrative process than for production and logistics."

R.Hradílek: "I agree that the coming market changes will affect the organisational structure and company culture of large ICT suppliers. Such changes have taken place in IBM

during the merger with PWC. ICT companies will have to train many new specialists in the sale of services – we shall be looking at new graduates for this type of role.”

J.Kameníček: “The important factors in the next development of the ICT market will be:

- labour costs. Therefore, service companies will not be just large global companies such as HP or IBM. Although these companies will have a large market share, there will be room for smaller, locally active companies, with lower labour costs and detailed knowledge of the customer. This will be most apparent in the SME market. The key problem for these companies will be whether they will get a critical mass of customers (users),
- the ability of start-up companies to enter new untried market segments and to offer more innovative as well as more risky types of services will ensure their success in the market.”

M.Bednár: “The return of hardware and software products to their makers is more relevant for hardware than software companies. The question of who is interested in this sort of business depends on whether the service is focused on the operation of ICT infrastructure or whether it also includes a responsibility for outsourcing of business processes. In the latter case, there will be room for specialist companies. For example, outsourcing of payroll and human resources has consequences well beyond ICT. The main expertise of such providers will be in human resources and social sphere, not in ICT.”

IV. Impact of the trends on universities

The changes in the focus of suppliers and users of IS/ICT will be reflected in the number of ICT graduates that will be required and the type of qualification they will need. The following changes can be anticipated:

- lower demand for purely technological professionals due to the decrease of such specialists in end-user organisations. However, technologically oriented graduates will continue to be in demand by suppliers. The knowledge required will not be just the development of new application but also deployment and management of secure and highly available operation of applications used by thousands of users.

The evidence for the lower demand for technologically oriented specialists comes from Australia. In 2004, the average Australian unemployment was 5.7%, but in ICT, it was over 10% and for programmer 18% [16].

The lower demand for technological professions will not be so marked in the countries of Central and Eastern Europe. The reason for this is the transfer of a number of development and operations centres of large suppliers to this area (e.g. the Sun Microsystems and CA development centres in Prague).

- high demand for specialists who are able to integrate ICT with business processes – the knowledge they require is described in section above. The graduates with two specialisations will be in very high demand – e.g. those who major in ICT and minor in production logistics.

V. Conclusions

The key trends that will be affecting utilisation of ICT in end-user organisations are:

- process-management of an enterprise and its ICT,
- endeavour for a unique and effective integration of ICT with entrepreneurial activities, company culture and business processes so that the enterprise can respond more quickly to important events, lower costs, increase quality and/or offer new products/services to customers,
- management of the relationship between business and ICT using ICT services,
- allocation of responsibilities for costs and benefits of ICT between business and ICT managers,
- utilisation of scalable ICT services,
- increasing proportion of externally supplied ICT services in the form of outsourcing or classical ASP.

A gradual development in the direction described here will have an impact on both the suppliers and users of ICT. These changes will be applicable to the core business of many companies, and thus the composition and qualifications of their workforce.

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Assessing of a New Customer Services System's Use in Internet Environment

Chuan-hua Zhou¹, Bao-hua Zhao²

¹ School of Management Science and Engineering, AHUT, P.R.China, 243002

² University of Science and Technology of China, P.R.China, 230026

Tel./Fax: 86-555-2400854 E-mail: chzhou@ahut.edu.cn

Abstract: Assessing use is very important for organizations selling and using customer services system in Internet environments. Based on a conceptual model, this paper is to empirically study individuals' assessments of a new customer services system in Internet environment. The model has three phases; pre-use, test and use. In relation to the three phases, the concepts of value and quality are discussed. The main contribution of this paper is the understanding of the difference between the concepts of value and quality being illustrated in the conceptual model. Customers' assessment of value and quality could have implications for companies developing new customer services system in Internet environments.

Keywords: Assessment, Customer services system, Quality, Value.

I. Introduction

Assessing use is of vital importance for organizations selling and using services in Internet environment (Davis et al., 1989; Philip and Hazlett, 2001). In the areas of information technology and management the introduction by Davis (1989) of the technology acceptance model (TAM), was in many ways pioneering in understanding the psychological factors influencing information system use. Davis emphasizes the role of the individual in the organization. Furthermore, Orlikowski (2000) puts forward that since most technologies can be used in a number of ways, users shape the meaning of technologies as they integrate them into everyday practice. Emphasized in this paper is the users' interaction with technology solutions in everyday practice in an organizational context.

Bobbit and Dabholkar (2001) share a similar understanding as Davis (1989) when they put emphasis on attitudinal beliefs to predict and understand use of technology-based self-services. Not entirely emphasized in the models by Davis (1989) and Bobbit and Dabholkar (2001) is a broader understanding of usage than attitudes and intentions of usage, because intentions predict use, but not usage over time (Chau, 1996). Karahanna et al. (1999), on the other hand, put forward the importance of studying technology adoption across time. Karahanna et al. highlight the importance of organizational issues and the affect on the individual, particularly for potential adopters of information technology. A framework is presented where they

combine innovation diffusion and attitude theories to study differences in pre-adoption and post-adoption beliefs and attitudes. The consciousness of the difference between adoption and usage is a critical factor when understanding adoption. The importance of different phases in time, by Karahanna et al. (1999) labelled pre- and post-adoption, is of equal importance in this paper.

In addition to the distinction, made by Karahanna et al. (1999), in pre-adoption and post-adoption, a middle phase is implemented in the conceptual model presented in this paper. The middle phase is labeled the test phase. The reason why assessment of usage of a new customer services system in Internet environment should contain an additional phase is users involvement in development processes and its affect on users' assessment of the service in Internet environment in the test phase. Therefore, when users are involved in the development process of a new service in Internet environment, the assessment of usage should be based on three phases (Figure 1). The purpose of this paper is to use a conceptual model (Figure 1) to empirically study individuals' assessments of a new customer services system in Internet environment over time.

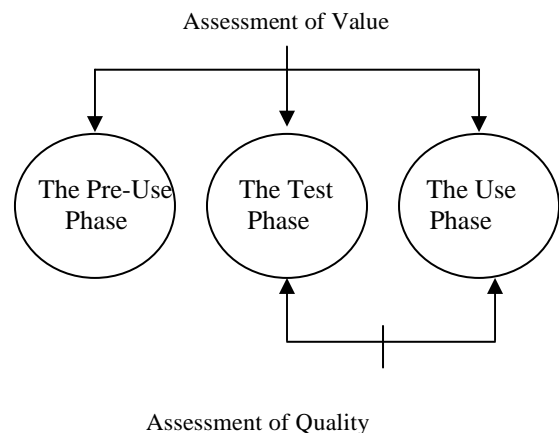


Fig. 1 User Assessment of Value and Quality of a New Service in Internet Environment.

In connection with these three phases, two concepts of great importance for user assessment will be discussed. The concepts are value and quality. McDougall and Levesque (2000) put forward that the concepts of quality and value are closely linked; "quality is just one side of the satisfaction equation." (p. 403). However, the difference between the concepts of value and quality is the main contribution of the conceptual model (Figure 1). The underlying principle of our model and the reason why the concepts of value and quality

are important is that users' ability to assess the value of a service in Internet environment is possible without usage. As for quality assessment, usage of the service in Internet environment is a requirement.

The structure of this paper is as follows; first, a brief introduction of the concepts of value and quality will be carried out. Thereafter, a discussion of the three phases will be presented with regards to the concepts of value and quality. In conjunction, early results from an ongoing study will be presented. Data collection in this study has been generated by the means of qualitative in-depth interviews over a period of two years. Interviews have been conducted with four pilot-customers of a new service in Internet environment in three different time phases, i.e. the pre-use, the test and the use phase.

II. Value

Perceived value is a difficult concept in that it is hard to define and measure (Zeithaml, 1988; McDougall and Levesque, 2000). Broadly defined, perceived value is the results or benefits customers receive in relation to the total costs. In other words, it is the difference between perceived benefits and costs (McDougall and Levesque, 2000).

According to Zeithaml (1988), customer-perceived value is the consumer's overall assessment of the utility of a product based on a perception of what is received and what is given. This can vary between people but also from occasion to occasion for the same person (Zeithaml, 1988). Caruana et al. (2000) state; "value is seen to be more individualistic and personal than quality and involves both a give and get component" (p. 1339). Raval and Grönroos (1996) suggest that customer-perceived value has to be related to different personal values, needs and preferences. In addition, they state, that the financial resources of the consumer must be taken into account.

III. Quality

Quality originates from Latin and means the attribute or the constitution of something. The ground of the competition is made up by the customers' experience of quality in relation to the costs (Edvardsson, 1996). Grönroos (2000) presents the concept of total perceived quality building upon the gap between expected and experienced quality.

Palvia et al. (2001) present a socio-technical framework for quality assessment of computer information systems. When assessing a system, the authors state; "the quality of an information system should be concerned with both the technical and the social subsystems. The technical subsystem covers the nature of the tasks to be accomplished and the technology that enables their accomplishment. The social subsystem involves the individuals who are responsible for accomplishing the tasks and the means whereby their work can be coordinated. In short, the assessment of system quality reflects the task, the supporting

technology, the people involved and the organization" (p. 238).

For individuals and organizations, value and quality are two important aspects. As a consequence, questions about how value and quality are perceived by individuals are essential when services in Internet environment are developed and assessed. Below, the concepts of value and quality will be discussed in conjunction to the three phases of the conceptual model (Figure 1). Based on a chronological order, the first phase, the pre-use phase will be presented, followed by the test phase and finally the use phase. The presentation will focus on theoretical as well as empirical findings.

IV. Empirical results

For individuals and organizations, value and quality are two important aspects. As a consequence, questions about how value and quality are perceived by individuals are essential when services in Internet environment are developed and assessed. Below, the concepts of value and quality will be discussed in conjunction to the three phases of the conceptual model (Figure 1). Based on a chronological order, the first phase, the pre-use phase will be presented, followed by the test phase and finally the use phase. The presentation will focus on theoretical as well as empirical findings.

IV. 1 The Pre-use Phase

The first phase in the conceptual model is the pre-use phase. At this point the potential user has a service present-at-hand, which means that information about the service and/or visual experience are the only sources available for the potential user to assess the service in Internet environment (Winograd and Flores, 1996). The importance of the pre-use phase is highlighted by Barki and Hartwick (1994), where they argue that it may be more easy to change users' "thoughts and feelings" before implementation. Early results from the study show an overall positive attitude towards the future service in Internet environment. Possible explanations could be that users perceive the service in Internet environment to be valuable or that users involvement in the development process has influenced users thoughts and feelings in a positive manner.

Davis et al. (1989) state that the most vital problem, when assessing user acceptance of IS in the early stages of development, is the difficulty to give users a clear picture of features and functions of the new system. Likewise, our study shows that although pilot-customers were given a short introduction in the early stages of the development of the upcoming service in Internet environment, they had difficulties in expressing opinions about the quality of the service.

Davis et al. (1989) discuss the importance of finding new methods for evaluation of acceptability of a system as early

as possible in the development of information systems. This could better help to decide if the system needs to be changed and decrease the risks of developing a system that is not going to be used. The overall picture in our study is that pilot-customers feel that they have had good opportunities to share opinions and concerns regarding the upcoming service in Internet environment. Pilot-customers concerns of missing features and functions in early presentations of the upcoming service in Internet environment were taken into consideration and later developed and implemented into the service. In line with the conceptual model (Figure 1), pilot-customers in the pre-use phase were able to express general opinions about quality issues, but not to make assessment of quality issues. However, assessment concerning values of features and functions of the upcoming service in Internet environment were possible to express opinions about.

IV. 2 The Test Phase

Emphasized by Davis et al. (1989) is the interest in the possibility to forecast and explain user behavior after a very short time of interaction with a system. In order for computer systems to improve organizational performance they must be used (Davis et al., 1989). As the users interact with the service in Internet environment in the test phase, it is possible to form a judgment about the quality, or excellence of the service (Zeithaml, 1988). After the pilot-customers had used the in Internet environment service for approximately a month, value and quality assessment were easier to express opinions about.

Orlikowski (2000) points out that technology users shape the meaning of technology as they integrate them into everyday practice. In other words, technology structures are not external from the user. In the test phase, the user repeatedly interacts with the service in Internet environment, which shapes their view about it and accordingly their use. Davis (1989) suggests that two determinants, "perceived usefulness" and "perceived ease of use", are especially important when people accept or reject information technology. Both variables influence users' attitude, intention and finally behaviour. In the test phase, as in the pre-use phase, the role of the individual is critical. It is of utter importance for the success of the application that the user finds it useful and easy to use. In our study, pilot-customers expressed difficulties in using the service in Internet environment for the first time. It was not obvious how to make an error-report in the service in Internet environment, although error-report is an essential function of the service. Pilot-customers assessments are important to take into consideration in the test phase since the determinant "perceived ease of use" (Davis, 1989) will have an influence on users behaviour in the use phase.

IV. 3 The use phase

In the test phase, but even more apparent in the use phase, the user gradually becomes more aware of the service in Internet environment not only in the own working tasks but

also in the organizational context. As Palvia et al. (2001) point out, when assessing a computer information system, a wider socio-technical view is important. Therefore, the quality of a computer information system should be concerned with both the technical and the social subsystems. A longer use of a service in Internet environment in an organizational context, "technology-in-practice" (Orlikowski, 2000), will have implications for users' judgment when assessing the service in Internet environment in the use phase.

Hu et al. (1999) state that the organizational context is new to IT acceptance and adoption research. Taylor and Todd (1995) argue for the importance in understanding determinants of information technology usage in organizations. Barki and Hartwick (1994:77) state that when new systems have been implemented and used, feelings and thoughts among the users were "likely to have greater impact on the use of new systems". In accordance with Taylor and Todd (1995), the importance of organizational issues and its affect on users' assessing services in Internet environment will be stressed throughout the use phase.

V. Conclusion

Our findings in the pre-use and the test phase indicate support for the conceptual foundation of the model (Figure 1) that is, the difference between the concepts of value and quality in relation to user assessment in three time phases.

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Using Adaptive Structuration Theory to Study the Implementation of CIM Systems: A case study of TFT-LCD Companies

Jer-Wen Chen, Dr. Ho, Chin-Yuan, Dr. Su Bo-chiuan
Institute of Information Management, National Central University
No. 300, Jung-da Rd, Chung-Li City, Taoyuang, Taiwan, 320, R. O. C.
TEL : (886-3) 426-7251-6500 ,FAX : (886-3) 426-7251-6500
jerwen01@ms13.hinet.net, ncu6500@ncu.edu.tw

Abstract: CIM (Computer Integrated Manufacturing) is like a strategic weapon that helps industries increase their capacity for competing. Case study by interviewing enterprise is the main technique applied in this research. Base on AST (Adaptive Structuration Theory) introduced by multiple case analyses, in the process of implementing CIM the interaction between CIM and organization of two TFT-LCD industries whose business operation characteristics are different will be discussed. The research result can be treated as a reference for enterprises to perform their CIM system more effectively and promote their core competency.

In the paper, some discoveries are found as follows: the enterprises that have higher degree of automation always pay more attention to the operation standard of manufacturing and system, and consider the correspondence between them for need of process automation. On the other hand, the enterprises that have lower degree of automation always pay more attention to the rationalization of production lines, the convenience of adjusting operation process after the system is implemented, division of labor among the related organizations and their responsibility as well. The reason why causes the difference is the former thinks both the system functions and information linking techniques are two most important key points in the CIM project, so the employee rate of the staff related with IT must be increased in the project organization.

I. Introduction

Many researches are proposed to mention about the successful key factors of introducing information technology system. In the recent years, however, observing the interaction between information system and organization in a view of sociology is one of academic research directions. The research motivation is to try to understand operation planning, introduction process, system performance and organizational performance of introducing information system through the interview analysis of the study case.

As information technology (IT) popularizes, in addition to semi-conductor industries, other high technology industries such as TFT-LCD industries, are also introducing manufacturing execution system (MES) gradually. In view of business owner, the introduction cost of MES is about

5~10% of whole plant construction cost. However, the success or failure of MES introduction deeply influences the operation condition of production lines. Therefore, most managers of manufacturing industries pay lots of attention to the MES introduction. Not only planning of automatic production lines has to be managed by MES, but also the case company introduced MES based on customer requirements.

Therefore, through the case study on the high technology manufacturing industry with different models of production operation management, this paper discusses the following questions to help enterprises with different planning of production lines introduce CIM related project.

1. Which factors will influence the selection consideration to the introduction of CIM in an enterprise organization? How?
2. How do CIM and the fitness of organization influence the process automation?
3. How does the introduction of CIM influence the performance of enterprise?

The research purposes is to use theoretical structure in Adaptive Structure Theory (AST) to observe the interaction between CIM system and organization in the introduction process of CIM, base on the case study on the different types of production operations. The discovered relations in the paper can help enterprises to effectively use CIM system to enhance the enterprise competence.

II. Literature Review

Roach [5][6] proposed the phenomenon of "Productivity paradox". Strassman [7] also stated there is nothing which can prove that his investment in 1980 had got returned. However, other researches such as Marri et al. [4], depicted the introduction of CIM could obviously raise production efficiency, quality of product, and lower inventory as well.

Giddens [2] proposed the duality of structures and in an agile point of view claimed individual activities are not only purely obeying rules or doing routines but also make social structure changed by the applications of knowledge concepts. Gregor and Johnston [3] thought that theory which can be applied in developing a cross-organizational information system should equip with the process of multiple-level analysis, be able to explain the organizational behaviors in different time, and support the theory of emergence.

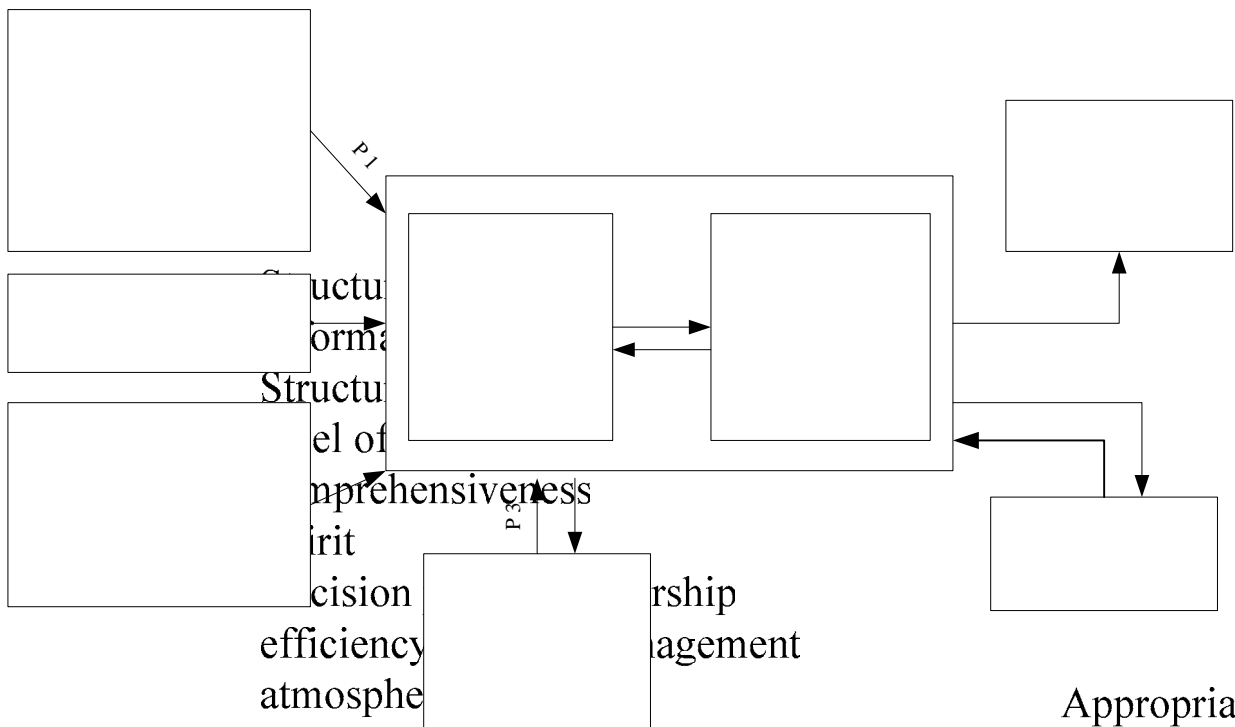


Fig. 2.1 AST theory architecture

(Source: DeSanctis and Poole, 1997)

Among these theories, Giddens' structural behavior theory is the most appropriate to be applied in the research on cross-organizational information system.

DeSanctis and Poole [1] proposed Adaptive Structure Theory: AST. It was used to discuss the interaction between the introduction of advanced information technology and organization in an enterprise. The structure is as the above figure 2.1.

The research implements the process of empirical study by making use of AST, and try to understand what the staffs think and their concepts in different organizations and enterprises while the information system is being introduced. Moreover, the difference of interaction among organizations in an enterprise will be observed when CIM system is introduced.

III. Research Structure

III.1 Assumptions

The research adopts multiple-case-multiple-interview method to realize the concepts and the thoughts of all kinds of staffs in the organizations in the introduction process of CIM system through the comparison of interviewing information. In the paper, two TFT-LCD manufacturing companies with different degrees of automation are selected as the subjects of the case study. The introduction performance of CIM will be compared, base on the description of those staffs in the

organization.

There are seven assumptions proposed as follows:

The structural characteristics and the design concept of CIM system always influence the process of social interaction while introducing CIM system.

Because when the function and the information of CIM system have been upgraded, the system stability will be more important to production lines.

Assumption 1: system characteristics

P1b	The higher stability of CIM system and the higher instantaneity information processing will be more helpful to process automation.
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The operational characteristics of organization will influence the selection and introduction of CIM system. Once the system got sophisticated, it is easily found that there is a proportional relationship between the participation degree among information staffs to CIM system and the leading selection degree of system.

Assumption 2: organizational characteristics

P2b	The higher degree of production automation is, the higher leading selection degree of CIM system the information staffs have.
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The personality of users will influence the selection of CIM system. In the paper, the attitude of system users who take part in the project of CIM system was observed to realize whether the process automation is proportional to organization after the introduction of CIM system.

Assumption 3: characteristics of users

P3b	The more positive attitude of system users who take part in the introduction of CIM system, the more possible the goal of the process automation will be achieved.
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The assessment and selection of a system is a kind of interaction among systems and organizations. Moreover, the way to design the system is a key factor in the process of assessment and selection. The content of design should be followed the need of organization, and process automation is one of the main purposes in the introduction of CIM system. Hence, P4b also became another assumption proposed in the research.

Assumption 4: the assessment and selection of system

P4b	If the design of CIM system is more fit to the need of organization, then the degree of process automation is higher.
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The difference of the participation degrees and application methods of the project-related staffs will influence the project much.

Assumption 5: emergent structure

P5b	The higher degree of process automation usually comes after a large portion of information staffs in the project of CIM system.
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It helps on achieving the final goal of process automation.

The introduction of CIM system will affect the current organization, so the collaboration degree of organization in charge of the system maintenance will be higher.

Assumption 6: new organizational structure

P6b	The degree of process automation and the collaboration degree of organization in the information department will be higher after the introduction of CIM system. The stability of CIM system can be maintained or increased through the maintenance operation of information department.
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As managers demand the facilities be used effectively, a organism which increases the usage of facilities and production yield of production lines can be constructed through systematically monitoring management of production process.

Assumption 7: organizational performance

P7b	The introduction of CIM can improve the performance of production lines; the higher degree of process automation will bring higher system efficiency.
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Base on the above assumptions, the research structure is arranged as the figure 3.1 shows.

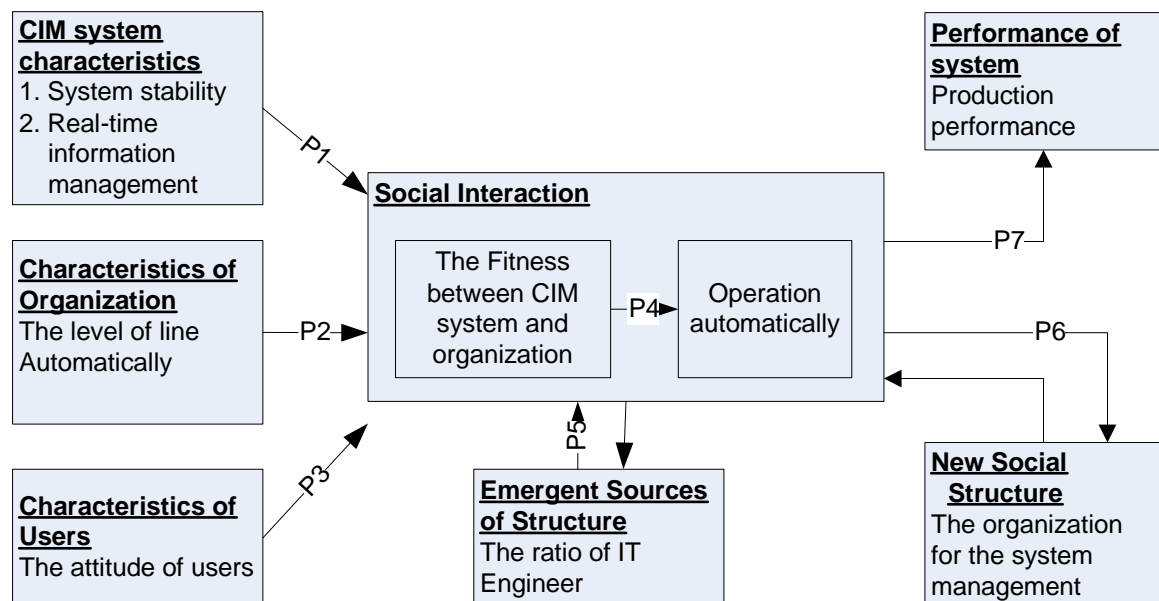


Fig. 3.1 research structure

III. 2 Planning of Interview Subject and Operation Model

To enrich the interviewing content of cases and collect the information of related research issues more completely, the interviewing subjects should be the most important roles really devoted to the introduction of CIM system, and they also can process the data collection in different points of view, such as the view of enterprise managers (Business unit managers, information system managers, production line managers), the view of system maintainers (information managers, information system engineers), the view of system users (production line managers, production line operators). The occupational structure of the interviewing subjects is as figure 3.2.

IV. Case Study

The purpose of this research is to compare the processes and results of the introduction of CIM system in the two different operation-based companies. The comparison can be the following two ways:

☆ Assumption-based analysis:

The aim of is to investigate every occupational role in a company to know their idea and their thoughts of a series of assumptions, and then find out the same and the different depictions in these two companies. Through the results of assumption-based analysis, it might be found the interaction among systems and organizations in the introduction process of CIM system in the different operational base companies.

☆ Occupation-based analysis:

The aim of occupation-based analysis is to ask every occupational role in different companies for knowing their idea and their thoughts of each question, and then analyze the reasons of these descriptions. Finally, the effect of every occupational role on CIM project will be known.

According to the arrangement of the interviewing content, some conclusions are found as follows:

(1) Which factors will affect the selection consideration of the introduction of CIM system in an enterprise? How?

This question can be illustrated from three aspects, namely, characteristics of system, characteristics of organization, and characteristics of users:

Characteristics of system:

The characteristics of CIM system are a series of processes of assisting the automation of production operations and the treatment of engineering data. Both the stability of system and the demand of real-time information processing are proportional to the degree of operation automation.

Characteristics of organization:

In the automated operation based enterprise, the information department is in charge of the CIM system project. Also, the first consideration for the system selection is mainly the information department, and the selection standard is based on the performance of system introduction.

Characteristics of users:

In the semi-automated operation based enterprise, the participation attitude of users is more positive, and they are the managerial core of operational process and system function.

(2) How CIM system and organizational fitness affect the process automation?

The case company A is based on operational automation, its organizational and operation process have had clear definition, and its system feature is to provide the managerial function of operation process; the main purpose of the case company B is to enhance the efficiency and the quality of operation, so the organization need to adjust or reconstruct the operation process during the process of system introduction.

As the cross-analysis of cases shown, the staffs in the enterprises with different degrees of automation have varied concepts and thoughts for CIM system so that the degrees of impact to organization are also different. For instance, the staffs in a production line with high degree of automation are more willing to pursue automation because of the standardization of production process and high unit price of each product. Therefore, the developing core tend to be placed on information department.

(3) After the introduction of CIM system, how it affect the performance of the enterprise?

Generally speaking, the introduction of CIM system usually helps enterprises to raise their performance. An enterprise with automated production operation will try to improve the level from operational automation to managerial automation, and implement more advanced appliance based on the data of CIM system. An enterprise with manual production operation will take advantage of the transparency of production data to make benefit from real-time management and quick response, especially for those who have more complicated manual production. The introduction of CIM system does affect the reconstruction of operation process a lot.

V. Conclusions and Future Works

Some conclusions are remarked here base on the arranged information of cross analysis of cases.

1. As the interview information shown, the interviewers all thought CIM system can improve the performance of production. The managers proposed the information

transparency of production lines will be helpful to managerial communication. Concerning about the benefit return of system, surprisingly, semi-automated operation based company B has more concrete cognition to benefit earning. Therefore, the research claimed the benefit return after the introduction of system is related with the profit-making business model but the degree of automation.

2. After researching the information of cases, we found the high portion of information staffs and what corresponds with the assumption P6b is high degree of process automation contribute mostly to the accomplishment of process automation. According to the observation of the case company's experience, the project staffs in the case company A evaluated a CIM system set-up for new factory always needs 20~30 information managers and information engineers. Among the different departments, the proportion of the users representatives employed to make sure the system requirements and senior engineers or senior managers in charge of projects is about one to five in the case company A but five to one in the case company B. If the time consumed in the project meeting is considered, the proportion difference between these two case companies will be ten times of the former.

3. For the enterprise with high degree of process automation, the connection operation specifications and standards between the production facilities and system in each production process should be noticed for successful introduction of CIM system. The other companies must notice the operation rationalization of production lines, the adjustment of operational process after introduction, and the confirmations of related organizational collaboration and responsibility. Briefly, there are three conclusions for related enterprises as follows

- (1) Raise the leading awareness of users will improve the introduction performance of CIM system.
- (2) For semi-automated operation based enterprises, they should consider the process reconstruction after the introduction of CIM system and the impact that the

proceeding schedule of project brings.

- (3) The higher degree of automation the case company has, the more stable system they should own.

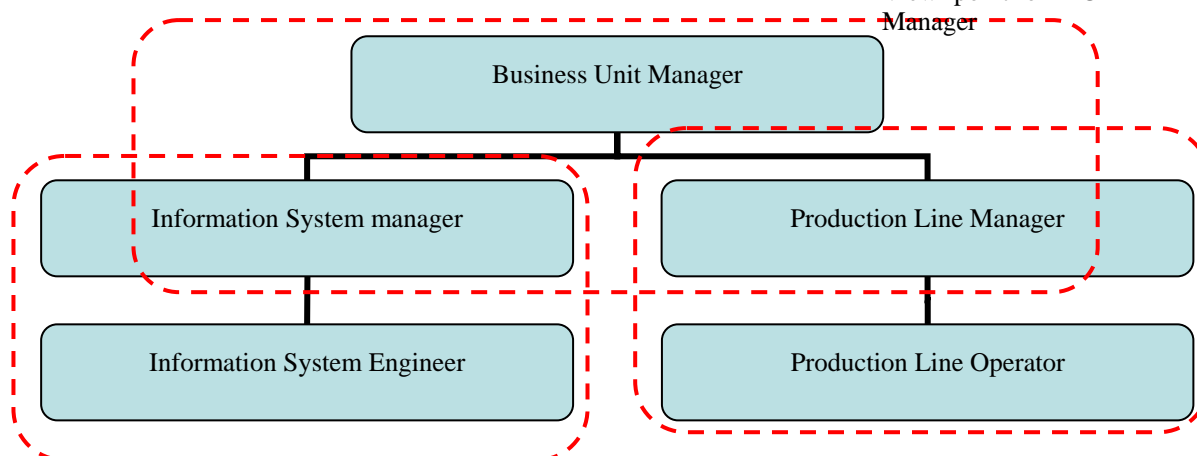
The research verified the interaction between the advanced information system and organization depicted by the AST model through the case interview information. Moreover, the cross analysis is also applied to realize what enterprises and the system integration industries should notice while introducing CIM system under different degrees of automation of production lines. However, more advanced interview information and comparison analysis is required to extensively apply the conclusions to other similar enterprises and industries. Meanwhile, to obtain the intact interview content, it is a good way to make the assumptions under the AST models the question items in the questionnaire to verify the acquired information, that can increase the reliability of the information.

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View point of BU

Manager



View Point of IT Supplier

View Point of IT user

Fig. 3.2 occupational structure of the interviewing subjects

Managerial Use of Broad Scope MAS Information – A Function of JIT and ICT: An Exploratory Study

Lanita Winata, Lokman Mia
School of Accounting, Finance and Economics
Griffith University, Australia
Email: L.winata@griffith.edu.au
Ph: 61 7 5552 9083

Abstract: Is managerial use of the broad scope MAS (management accounting systems) information a function of JIT implementation and ICT? This study attempts to address the above question. The research propositions are developed following the relevant literature on MAS information, ICT and JIT. Seventy-six general managers, each in charge of one strategic business unit (SBU) within their respective organizations, participated in the study. Data was collected from the SBU general managers using a survey questionnaire. The results reveal that just-in-time manufacturing (JIT) implementation and managers' use of information and communication technology (ICT) are determinants of their use of the broad scope MAS information.

Keywords: JIT Manufacturing, Information Technology, MAS Information.

I. Introduction

Today's intensified global competition in the marketplace encourages firms to attain competitive advantage by offering greater range of quality products at competitive price and being customer responsive. (26) for instance, argue that organizations facing high competition ought to focus their alternatives on identifying and meeting customer desires, producing superior products and becoming more market orientated. These competitive pressures act as impetus for firms to employ strategies suitable to deal with their market conditions. The implementation of the JIT is one such strategy. There is also a body of literature (2) suggesting that broad scope MAS information provides necessary feedback on aspects of operations including cost, production, wastage, defect, inventory level, idle time, breakdown, stoppage, capacity utilization, market share and sales. Since a JIT implementation is aimed at controlling/improving the above aspects of operations, we posit that managers in JIT environments would use relatively more broad scope MAS information. JIT firms need to routinely communicate with all parties in the supply chain for effective management of the chain (18). Managerial use of the ICT improves efficiency of a supply chain management and integration through improved speed and flow of information and data exchange between the chain members. We argue that

managers' use of the broad scope MAS information in a JIT environment is augmented by their use of ICT as it makes availability and exchange of necessary information instantaneous, be it at the customer's site, at the production process or at the supplier's end. Following the above discussion we proposed and test the three hypothesis below:

H₁: Managers' use of the MAS information is positively associated with the JIT implementation.

H₂: There is a positive association of managers' use of the ICT with their use of the MAS information.

H₃: The interaction between managers' use of the ICT and implementation of JIT is positively associated with their use of the MAS information.

II. Method

II.1 The Sample.

Using the Dunn and Bradstreet 'Salescan' database, 360 firms were selected at random for the study from among the manufacturing firms operating in Australia and having annual sales revenue of \$300m to \$650m. In total, 79 SBU general managers completed and returned the questionnaire within nine weeks of mailing the questionnaire. Three of the questionnaires had to be discarded, as they were incomplete, leaving 76 cases in the final sample.

II.2 Measurement of Variables.

JIT implementation was assessed following Sakakibara, et al (39) on a six item scale arranging from 1 (very low) to 7 (very high).

Information Technology for Communication (ICT) was assessed using the 5-item instrument was adapted from (1) on a 7-point Likert-scale anchored at both ends. '1' represented a 'low use of ICT' and '7' represented a 'high use of ICT'

Use of the MAS Information was assessed using the 6-item instrument (adapted from (31) on a 7-point Likert scale ranging from 1 (not at all) to 7 (to a great extent).

III. Results

Recall hypotheses H₁ predicts that managers' use of the MAS information is positively associated with the JIT implementation and H₂ predicts that there is a positive association of managers' use of the ICT with their use of the

MAS information. Equation 1: $Y = \beta_0 + \beta_1 \text{JIT} + \beta_2 \text{ICT} + e$
 The results supported hypothesis 1 and 2, but not hypothesis 3.

IV. Discussion, Conclusion And Limitations

The significant and positive associations between the managers' use of the broad scope MAS information and their use of the ICT, and implementation of the JIT are encouraging. The significant and positive MAS - JIT association indicates that managers working in a JIT environment find broad scope MAS information are useful, therefore they use the information. The results support our argument early in the paper that managers in a JIT environment enjoy delegated authority for making decisions on the spot to ensure smooth running of operations, therefore they need to use a wide range of necessary information for decision-making. Broad scope MAS, by providing a wide range of quantitative and qualitative, financial and non-financial as well as ex-post and ex-ante information, is well suited to meet the managers' information needs. The study extends (31) by testing the relationship between JIT implementation and managers' use of the MAS information. Although (31) investigates the relationship between provision of the MAS information and SBU performance in JIT and non-JIT firms, managers' use of the MAS information in JIT environment is not tested.

The significant and positive MAS - ICT relationship supports our fundamental argument in the paper that ICT, through computerised network, assists managers in using broad scope MAS information. Since this type of MAS comprises a wide range of information as discussed above, managers using such information are faced with handling significantly large volume of data (cues) for decision-making. ICT, a computerised network with a capacity to handle voluminous data with lightning speed and unparalleled efficiency, assists managers' in using the MAS information and in carrying out interpersonal communication. Thus, the study extends research on ICT to financial information. Although there has been a significant amount of research on information technology for communication (see for instance Andersen 2001), none of the studies investigates the effect of ICT on managers' MAS information use in JIT environments.

Just like other studies conducted in field settings, the following limitations to the current study are worth mentioning here. First, the study was based on the manufacturing industry only, therefore, the results may be manufacturing industry specific. Given that JIT is applicable in service organizations and that cost structures in a service organisation is different from that in a manufacturing organisation, future research investigating the impact of market competition, JIT implementation and managerial use of the MAS information in service organizations will be beneficial.

Second, while considerable care was taken in selecting

the sample, participation of the SBU general managers in the study was voluntary. Thus, there is potential for self-selection (response) bias in the sample. For example, it is plausible that those companies which were successful in the JIT implementation and/or those that were performing well might have decided to participate in the study, whilst those that were not so successful in JIT implementation and/or not performing so well might have abstained.

Third, although considerable care was taken in devising measures for the variables in the model, there is still room for improvements. Future studies would benefit from taking care of this potential problem in formulating the research design. Although the current study pioneers the assessment of JIT implementation with respect to six key aspects, it did not collect data on the period for which each of these aspects had been in use by the respective SBUs prior to the study. Information on this issue might have made the results more informative. Following the relevant literature this study used perceptual measure to assess the extent of JIT implementation in the sample firms; using objective measures (where available and applicable) to assess the construct in future studies might make the results more informative. Consistent with its focus, this study assessed the extent of managers' *use*, not *usefulness*, of the MAS information (8). Incorporating measures of both managerial use and perceived usefulness of the information in future studies might produce more informative results.

Notwithstanding the above limitations, the results of the study have implications for theory and practice. The implication for theory is that the results provide empirical support for the prescriptive studies advocating use of broad scope information in just-in-time manufacturing environment. So far empirical research on JIT has been mostly prescriptive (39). Although prescriptive research is an important step towards developing theory, empirical research is a step forward to testing the theory in reality. Moreover, the study also provides empirical support for the view that organizations' manufacturing strategies like JIT create needs for managers' use of appropriate information systems such as the broad scope MAS and ICT helps the managers in making effective use of such systems.

One implication for practice is that an organisation which plans to implement a strategy like the implementation of JIT may perform better if it also upgrades/modifies concurrently its MAS and ICT. This implies that the organisation upgrades/designs its MAS to meet the managers' information needs; otherwise, realisation of the full benefits of implementing the strategy may be at least slow. Another practical implication for the results is that organizations that apply JIT could design MAS as such that the system has a built-in mechanism to identify and meet managers' information needs as they emerge, and thereby improve the system's relevance. The system's ability to meet the managers' changing information needs in an organisation is vital to the system's relevance; if it does not provide the necessary information, managers will ignore it, thereby making it irrelevant to their decision making process (23)

(31).

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Integrating SPC and EPC for Multivariate Autocorrelated Process

Lee-Ing Tong¹, Chien-Hui Yang², Cheng-Yi Huang¹, Cheng-Chi Shou¹

¹Department of Industrial Engineering and Management,
National Chiao Tung University, Hsin-chu, Taiwan 30050, R.O.C

²Department of Business Administration,
Yuanpei Institute of Science and Technology, Hsin-chu, Taiwan 30015, R.O.C

EMAIL: litong@cc.nctu.edu.tw

TEL: +886-3-5731896

FAX: +886-3-5733873

Abstract: Statistical process control (SPC) is a widely employed quality control method in industry. SPC is mainly designed for monitoring single quality characteristic. However, as the design of a product/process becomes complex, a process usually has multiple quality characteristics related to it. These characteristics must be monitored by multivariate SPC. When the autocorrelation is present in the process data, the traditional SPC may mislead the results. Hence, the autocorrelated data must be treated to eliminate the autocorrelation effect before employing SPC to detect the assignable causes. Besides, chance causes also have impact on the processes. When the process is out of control but no assignable cause is found, it can be adjusted by employing engineering process control (EPC). However, only using EPC to adjust the process may make inappropriate adjustments due to external disturbances or assignable causes. This study presents an integrated SPC and EPC procedure for multivariate autocorrelated process. The SPC procedure constructs a predicting model using group method of data handling (GMDH), which can transfer the autocorrelated data into uncorrelated data. Then, the Hotelling's T^2 and multivariate cumulative sum control charts are constructed to monitor the process. The EPC procedure constructs a controller utilizing data mining technique to adjust the multiple quality characteristics to their target values. Industry can employ this procedure to monitor and adjust the multivariate autocorrelated process.

Keywords: multivariate process, autocorrelation, statistical process control, engineering process control, group method of data handling, Hotelling's T^2 control chart, multivariate cumulative sum control chart

I. Introduction

Statistical process control (SPC) is a widely employed quality control method in industry. The objective of SPC is to monitor a product/process quality and maintain the process to a fixed target value. The best known tool of SPC is the control chart, which is used to detect the unusual variations in a manufacturing process. When the control chart declares a process out of control, it indicates a problem

with the process and the process engineer should look for an assignable cause and try to remove it. Traditionally, control chart is designed for monitoring single quality characteristic. However, as the design of a product/process gets complex, a process usually has multiple related quality characteristics which must be monitored simultaneously. When a process has multiple quality characteristics, it seems reasonable to use a separate univariate control chart for each quality characteristic instead of using a multivariate control chart since the univariate control chart is easily employed and interpreted. However, because each univariate control chart has its own type I error and these univariate control charts are aggregated to monitor multiple quality characteristics simultaneously, the overall probability of a type I error will be increased, in other words, the false alarm will be increased. Another reason that a series of univariate control charts cannot be used to replace the multivariate control chart is these univariate control charts neglect the correlation among the multiple quality characteristics. The consequences of neglecting the correlation among the multiple quality characteristics will increase both type I and type II errors. Therefore, many studies proposed multivariate control charts such as Hotelling's T^2 control chart [4], χ^2 control chart [3], multivariate cumulative sum (MCUSUM) control chart [12,16], and multivariate exponentially weighted moving average (MEWMA) control chart [8] to monitor several quality characteristics simultaneously.

Both univariate and multivariate control charts require that successive measurements from a process are independent of one another. However, due to the effects of tool wear or sampling frequency, the data assembled from a process may exhibit autocorrelation. When the autocorrelation is present in the data, it increases the chance that the control chart will indicate a process shift when the process has not shifted. A few multivariate control charts have been developed to deal with the process with autocorrelated observations. However, these control charts have some practical drawbacks.

The objective of control charts is to detect some unusual variations in the manufacturing process. When a process is out of control but no assignable cause is found, in this case, the process can be adjusted by employing engineering process control (EPC). EPC is a process adjustment technique for control engineers. The concept of EPC is not to remove the assignable causes of departures from the target but to compensate for the drift in process output by

continuously adjusting the process. EPC assumes that there is a dynamic model connecting the process input and the process output. When the model is correct, the EPC technique will minimize the process variability and keep the process output close to its target. However, if assignable causes occur that are outside the framework of a dynamic model, EPC technique cannot compensate the disturbance completely, and consequently, the variability will be increased [11].

Although many studies proposed multivariate control charts to monitor multiple quality characteristics or autocorrelated process, integrating SPC and EPC for a multivariate autocorrelated process is rarely seen. This study presents an integrated SPC and EPC procedure to monitor and adjust multivariate autocorrelated process. The proposed SPC procedure constructs a predicting model using group method of data handling (GMDH) to transfer the autocorrelated data into uncorrelated data. Then, the Hotelling's T^2 and MCUSUM control charts are constructed to monitor the process. The proposed EPC procedure constructs a controller utilizing GMDH to adjust the multiple quality characteristics to their target values. Industry can employ the proposed procedure to monitor and adjust the multivariate autocorrelated process.

II. Literature Review

This section first introduces the multivariate control charts, and then SPC techniques for autocorrelated process are reviewed. In the third subsection, the studies related to EPC are described. The method of GMDH is introduced in the last subsection.

II.1 Multivariate Control Chart

Hotelling's T^2 control chart was extended from the Shewhart control chart. It was the first developed multivariate control chart for monitoring several identically and independently distributed quality characteristics [4]. Hotelling's T^2 statistic to monitor several quality characteristics simultaneously is employed where assuming the covariance matrix of the quality characteristics is unknown. When the covariance matrix of the quality characteristics is known, the χ^2 statistic is used. Although the computation of Hotelling's T^2 control chart is more complicated than that of Shewhart control chart, when several correlated quality characteristics must be monitored simultaneously, Hotelling's T^2 control chart outperforms Shewhart control chart [4].

The MCUSUM control chart proposed by Woodall and Ncube [16] was extended from the univariate CUSUM control chart. Although the MCUSUM control chart is easy to employ, there may be a delayed reaction to a sudden large shift in the mean. Pignatiello and Runger [12] proposed two types of MCUSUM control charts which were designated as MC1 and MC2 control charts. Their study compared the effectiveness of the two proposed MCUSUM control charts with Hotelling's T^2 control chart and the MCUSUM control chart proposed by Woodall and Ncube. The results indicated

that the abilities of detecting small shifts in the mean vector from the MCUSUM control chart proposed by Woodall and Ncube and MC1 control chart are better than that of Hotelling's T^2 control chart. However, when there is a sudden large shift in the mean, the performance of Hotelling's T^2 control chart is better than that of MCUSUM control charts. Furthermore, the average run length (ARL) of MC1 control chart is more stable than the other three control charts.

Hotelling's T^2 control chart only uses the information gained from the current sample to determine whether a process is out of control, therefore, Hotelling's T^2 control chart is insensitive to small shifts in the mean vector. While MCUSUM control chart uses the information gained from the historical and current samples, therefore MCUSUM control chart is sensitive to small shifts in the mean vector.

II.2 Control Charts for Autocorrelated Process

In recent years, many SPC methods have been developed for monitoring the univariate autocorrelated data, such as the exponentially weighted moving average (EWMA) control chart [6], cumulative sum (CUSUM) control charts [2,13,14], and residual charts [1,9]. A few multivariate SPC methods for monitoring the autocorrelated process are also developed. Notably, Theodossiou [15] has proposed a CUSUM chart and Kramer and Schmid [7] have proposed a multivariate EWMA control chart to monitor the autocorrelated process. However, there are some practical drawbacks of using these methods. A prominent drawback is when evidence of an out-of-control situation is observed, and the above methods fail to provide the quality characteristic(s) responsible for the data point which falls outside the control limits.

II.3 Engineering Process Control

In mechanical, chemical, and electrical engineering applications, EPC are usually implemented to reduce process's variability. EPC assumes that a variable, which is called manipulatable variable, can be adjusted to compensate for the drift in process output to keep the process output close to the target. EPC assumes that there is a dynamic model connecting the process input and the process output. If the model is correct, the EPC technique will minimize the process variability and keep the process output close to the target. However, if the assignable causes occur that are outside the framework of a dynamic model, the EPC technique cannot compensate the disturbance completely; in that case, the variability will be increased [11]. Montgomery *et al.* [10] have demonstrated that the performance of an integrated SPC and EPC procedure is more effective than the EPC procedure alone.

II.4 Group Method of Data Handling

Group Method of Data Handling (GMDH) [5] is applied in a great variety of areas in data mining. Inductive GMDH algorithms aim to find interrelations of variables in a data set and select an optimal network or model structure. GMDH is an iterative method which successively tests models selected

from a set of candidate models according to a specified criterion. A general connection between the input and output variables can be found in the form of a functional Volterra series. A discrete analogue of Volterra series is Kolmogorov-Gabor polynomial which can be expressed as follows:

$$y = a_0 + \sum_{i=1}^M a_i x_i + \sum_{i=1}^M \sum_{j=1}^M a_{ij} x_i x_j + \sum_{i=1}^M \sum_{j=1}^M \sum_{k=1}^M a_{ijk} x_i x_j x_k + \dots \quad (1)$$

where $X = (x_1, x_2, \dots, x_M)$ is the vector of input variables and $A = (a_1, a_2, \dots, a_M)$ is the vector of summand coefficients.

The combinational GMDH algorithm has a multilayer iterative structure. The specific feature of GMDH is that the iteration rule does not remain consistent but expands with every new series. In the first series, all the models of the simplest structure are in the following form:

$$y = a_0 + a_i x_i \quad i = 1, 2, \dots, M \quad (2)$$

After sorting these models, select the best F models by a specified criterion.

In the second series, models of more complex structure are sorted. These models are constructed on output variables from the best models of the first series. The form of the models of the second series can be expressed as follows:

$$y = a_0 + a_1 x_i + a_2 x_j \\ i = 1, 2, \dots, F; \quad j = 1, 2, \dots, M. \quad F \leq M \quad (3)$$

In the third series, the sorting involves more complex structure form as follows:

$$y = a_0 + a_1 x_i + a_2 x_j + a_3 x_k \\ i = 1, \dots, F; \quad j = 1, \dots, F. \quad k = 1, \dots, M \quad F \leq M \quad (4)$$

The iterative procedure of the series continues until the criterion value stops increasing.

III. Proposed Procedure

This study develops an efficient procedure which includes two stages for monitoring a multivariate autocorrelated process. In the first stage, the SPC procedure constructs a predicting model using GMDH to transfer the autocorrelated data into uncorrelated data. Then, the Hotelling's T^2 and MC1 control charts are constructed to monitor a process to detect both large and small shift in the mean at the same time. If the process is out of control but no assignable cause is found, it can be adjusted by employing EPC to keep the multiple quality characteristics close to their target values. Therefore, in the second stage, the EPC procedure is proposed to construct a controller utilizing GMDH to adjust the multiple quality characteristics to their target values. The proposed two-stage procedure is described in Section 3.1 and 3.2.

III. 1 The Statistical Process Control Procedure

Constructing a multivariate control chart requires the analysis of a preliminary data set that is assumed to be in control and this data set is then used to construct a control chart for monitoring the process. Therefore, this section includes two phases. The first phase, designated as phase I, is to estimate parameters that will be used subsequently for on-going monitoring of the process. Phase I should utilize a very large sample of data so that the parameters and control limits are well-estimated for Phase II. Then, the second phase, designated as phase II, is to use the constructed control chart to monitor the process. The two phases are described as follows:

III. 1. 1 Phase I of the Statistical Process Control Procedure

This subsection presents a procedure to construct multivariate control charts for autocorrelated process. The procedure is described as follows:

Step 1: Collect and analyze the process data.

Assume that there are i input variables $x_1, x_2 \dots x_i$ and j quality characteristics $y_1, y_2 \dots y_j$ in the process. Draw univariate Shewhart control charts for the j quality characteristics to gain the information of the process data.

Step 2: Calculate the sample autocorrelation function of the data of each quality characteristic

Calculate the sample autocorrelation function for each quality characteristic and draw an autocorrelation function plot for each quality characteristic. If there is at least one quality characteristic exhibiting autocorrelation, go to Step 3; otherwise, go to Step 5.

Step 3: Construct a predicting model using GMDH

In order to eliminate the autocorrelation presented in the process data, this study utilizes GMDH as a predicting model to transfer the autocorrelated data into uncorrelated data to satisfy the assumption of independence of control charts. This study uses the observations of N periods before time t from the autocorrelated quality characteristic as the process input, and the process output is the quality characteristic of time t . After constructing the GMDH predicting models, the residuals can be obtained by subtracting the observation with the predicted value at time t . If the residuals satisfy the assumption of independence, they can be used to construct the control charts.

Step 4: Analyze the residuals

The residuals obtained from the GMDH predicting model must be checked whether the residuals satisfy the assumptions of normality and independence. If the residuals violate the assumptions, go back to Step 3 to modify the GMDH predicting model; if the residuals satisfy the assumptions, go to Step 5.

Step 5: Construct the multivariate control charts

Use the residuals to construct Hotelling's T^2 and MC1 control charts. If one of the Hotelling's T^2 and MC1 control charts reveals that the process is out of control, go to Step 6; otherwise, the Hotelling's T^2 and MC1 control charts show that the process is in control, and the Hotelling's T^2 and MC1 control charts can be adopted for constructing on-line statistical process control limits. Go to Step 1 of phase II.

Step 6: Deal with the out-of-control data points

Three ways to deal with the data points that fall outside the control limits are:

1. If one or two data points fall outside the control limits and the reason of the data points falling outside the control limits can be found and eliminated, then the data points can be eliminated, go back to Step 5 to construct new multivariate control charts.
2. If there are one or two data points falling outside the control limits but the reasons of the data points falling outside the control limit cannot be found, or the reasons can be found but cannot be eliminated, the data points will not be eliminated.
3. If three or more data points fall outside the control limits, it denotes that the process is out of control. The process engineer should find the problems and resolve them. After resolving the problems, go back to Step 1 and recollect the process data.

III. 1. 2 Phase II of the Statistical Process Control Procedure

This subsection presents a procedure to monitor a multivariate autocorrelated process. The procedure is described as follows:

Step 1: Record the information of the process data

Record the process number, machine number, the unit of quality characteristics, the name of operators, and the date of operation, etc. when using the control chart to monitor the process. If the data are recorded in details, the engineers can use this data to analyze the manufacturing process and then correct the process when the process is out of control.

Step 2: Specify the control limits of the control chart

Specify the lower and upper control limits of the Hotelling's T^2 and MC1 control charts constructed in phase I.

Step 3: Sample the data and use the constructed GMDH model to predict the future values of quality characteristics.

Sample the data from each quality characteristic y_{t-N} , ($y_{t-N-1}, \dots, y_{t-1}$) as the process input and use the constructed GMDH model to predict the future value of each quality characteristic, \hat{y}_t .

Step 4: Calculate the residuals

Subtract the predicted value obtained from the GMDH predicting model with the actual value for each autocorrelated quality characteristic, the residuals can be obtained.

Step 5: Draw multivariate control charts

Use the residuals to draw the Hotelling's T^2 and MC1 control charts. If there is any data point falling outside the control chart, go to Step 6; otherwise, the control charts denote that the process is in control and go back to Step 1.

Step 6: Diagnose the process and find the problems

If the Hotelling's T^2 control chart reveals that the process is out of control, the MYT decomposition method can be used to find the quality characteristic that causes the process out of control. If the MC1 control chart reveals that the process is out of control, the regression method can be used to find the quality characteristic that causes the process out of control.

Step 7: Remove the assignable causes

According to the result of the diagnosis in Step 6, if the assignable causes can be found and removed, go back to Step 1. If no assignable cause is found, implement the EPC procedure to adjust the process.

III. 2 The Engineering Process Control Procedure

Before employing an EPC procedure to adjust the multiple quality characteristics to their target values, a controller utilizing GMDH must be constructed. This study uses i input variables x_1, x_2, \dots, x_i as the process input and j quality characteristics y_1, y_2, \dots, y_j as the process output to construct the GMDH controlling model. The EPC procedure is described as follows:

Step 1: Compute the value of the quality characteristic that is out of control

Subtract the value of the quality characteristic which is out of control from its target value, then the value of the process drifting away from its target, $e_t = y_t - T$, can be obtained.

Step 2: Compute the compensative value of quality characteristic

Compute the compensative value of quality characteristic, $\hat{Y}_{t+1} = T - e_t$.

Step 3: Obtain the predicted values of input variables

The predicted values of input variables ($\hat{x}_{1,t+1}, \hat{x}_{2,t+1}, \dots, \hat{x}_{i,t+1}$) can be obtained using the compensative value of quality characteristic, \hat{Y}_{t+1} , and the GMDH controller.

Step 4: Choose the appropriate input variable as the

controlling variable

There are two criteria to choose the input variables as the controlling variable for adjusting the process. They are:

1. The range of the adjustment of the input variable is the smaller the better. This study defines the index of evaluating the range of the adjustment of the input variable as the ratio of the volume of the adjustment of the input variable and the standard deviation of the input variable.
2. The influence of the input variables on other quality characteristics is the smaller the better.

The controlling variable not only influence the quality characteristic that is out of control, but also influence other quality characteristics that are in control. Therefore, when choosing an input variable as a controlling variable, the influence of the input variable on other quality characteristics must be considered to avoid that the controlling variable influences other quality characteristics.

Step 5: Use the predicted value of controlling variable as a set-point

Use the predicted value of controlling variable as a set-point to adjust the process and then go back to Step 1 of phase II to proceed to monitor the process.

IV. Conclusion

This study develops an integrated SPC and EPC procedure for a multivariate autocorrelated process. The contributions of the proposed method can be summarized as follows:

1. Because the predicting performance of GMDH is good and the application of GMDH is easier than that of time series and neural network, this study uses GMDH to construct a predicting model to transfer the autocorrelated data into uncorrelated data and construct a controller to adjust the multiple quality characteristics to their target values.
2. Engineers with little knowledge of Statistics can apply the proposed procedure easily. This procedure is very helpful in judging the real process conditions.

3. This study adopts the Hotelling's T^2 and MC1 control charts to detect large shift and small shift in the mean at the same time. Therefore, the proposed procedure has better capability to detect the out-of-control data points.

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Discussions on the Environmental Strategies of SMEs

Sheng Li, Li Zhao, Haiying Zhang

(School of Business Administration, Southwestern University of Finance & Economics,
Chengdu, 610074, P. R. China)

Abstract: Environmental issues have become the focal point of society. However, China enterprises have not paid enough attention to environmental issues, especially those of SMEs. In this paper, it points out that environmental issues of SMEs are imperative. By analyzing the restrictive factors, we put forward four environment strategies based on internal capability and the pollution degree of the enterprises and analyze each strategy in details.

Keywords: SMEs; environmental issues; environmental strategy

I. Introduction

The increasingly serious environmental problems have managed to bring people into reconsideration of their behaviors. Environmental protection is not only concerned with the sustainable development of national economies, but also closely related to the future of human beings. To protect our earth and turn sustainable development into true, various countries have been actively taking part in bilateral and multi-lateral co operations, signing international environmental conventions, and being devoted to solve global environmental problems. Environmental problems caused by enterprises have become a big concern of governments and the public. A survey of British SMEs by Hillary (1995) revealed that 70% of pollution in Britain is caused by SMEs. In China, with the rapid growth of SMEs, SMEs have increasing contribution to industrial pollution, which has, actually, become the emphasis of industrial pollution control. According to a survey by China National Environmental Protection Bureau, pollution caused by SMEs makes up 60% of the national total. Faced with such a serious situation, it is undoubtedly indispensable for SMEs to implement environmental strategies and strengthen environmental management.

II. Urgency of Implement Environmental Strategies in SMEs

In China, SMEs account for 99.7% of enterprises in number, employ 73.3% of the total industrial enterprises staff and produce 66.9% of the total output by all the industrial enterprises. All these facts speak for the decisive position of SMEs in China's economy. However, environmental problems are seriously blocking the further development of SMEs, and it is inevitable for them to put environmental

problems onto the agenda for the following two reasons. On the one hand, it is a prerequisite to avoid green trade barriers. With economic globalization and China's entry into WTO, enterprises in China are exposed to complicated international trade regulations and rules, and a lot of countries in the world, especially developed countries, have set non-tariff barriers in various ways, for example, SA8000 standards in the U.S.A, AVE standards in Germany, ETI standards in the UK and ISO14000 international environmental standards, and so on. In China, SMEs are playing a key role in export; therefore, greening their products and production process have become a necessity. On the other hand, it is a precondition to improve the competitiveness of enterprises. Resource-based theories (RBT) point out that environmental problems have already become a significant factor affecting an enterprise's competitiveness (Russo & Fouts, 1997). Due to various factors like small scales, backward technologies, insufficient capitals, and inadequate ability to take risks, SMEs are suffering from heavier environmental pressure than large enterprises, and, more seriously, they even become the victim of fierce competition among enterprises. Consequently, against the background of increasing attention to enterprises environmental problems worldwide, SMEs should have a clear profile themselves, correctly cope with the opportunities and threats brought by environmental problems, adopt proper environmental strategies to foster their own competitive advantage, and improve sustainable development of enterprises.

III. Restriction Factors of SMEs Environmental Strategies

Environmental strategies are the overall programs for enterprises to collaborate all the production and operation activities with eco-environment. In this sense, enterprises' environmental strategies are restricted by two types of factors. Proper analysis of these factors is the precondition of working out counter measurements, and is beneficial to integrate their competitive factors and build environment-oriented competitive advantage. Generally, the restriction factors of SMEs are as follows.

The first factor is government regulation. At present, majority of enterprises take environmental protection actions with the purpose of influencing Government's environmental regulations. Increasing perfection of environmental regulations and rules has become an essential external condition to promote enterprises to strengthen environmental management. Due to the worsened environmental conditions, all the Governments have enhanced their intervention into the environmental problems, and promulgated relevant

regulations, for instance, the U.S.A has managed to issued a series of regulations like CAA (the Clean Air Act), CWA (the Clean Water Act), RCRA (the Resource Conservation and Recovery Act), CERCLA (the Comprehensive Environmental Response, Compensation and Liability Act), TSCA (the Toxic Substances Act), SARA (the Superfund Amendment and Reauthorization Act) and EPCRA (the Emergency Planning and Community Right-to-Know Act). Japan and some developed countries in Europe and even some developing countries have also issued some acts, which tend to be increasing strict. China has also issued a series of acts to protect water, atmosphere, and resources and eliminate solid waste materials, for example, Environmental Protection Law of the People's Republic of China, Atmosphere Pollution Prevention Law of the People's Republic of China, Water Pollution Prevention Law of the People's Republic of China, and so on. Usually, Government's intervention to the market would apply different effects on the enterprises in the industry; that is, this intervention would result in some winners and losers, namely, some unqualified enterprises forced to withdraw from the market, and others actively taking part in environmentally friendly practices and obtaining competitive advantage. China has started to handle the pollution problems of SMEs since 1995, and a special pollution rectification is carried out once a year. By 2004, the 10th rectification has been held, and approximately over 1,000,000 SMEs have been closed as a result of pollution problems.

Secondly, market acts as another factor. Pressure from consumers is the major restricting factor SMEs are facing. With speeding of the course of industrialization, deteriorating of global environmental pollution, existence and development of human beings are threatened, which has contributed greatly to the growing consciousness of environmental protection, and even the big turn of the people's way of thinking, values, consumers' psychology and behavior. Consumers gradually turn to green food, pursuing eco-health. They tend to pay a high price for the products of some environmental protection features, and refuse those enterprises and products with low environmental performance. Compared to the large scaled enterprises, SMEs could not produce products with high environmental performance, which, as discussed above, implies great threats to the further expansion of the enterprise, especially those exporting SMEs: without improvement of their products and collapse of the green barriers, they could hardly obtain any long-term development. Besides, pressure from the public, green competitors, green suppliers and potential green entrants to the market would also become the realistic threats to the enterprise, and therefore, they have to change their conventional environment-blind views and behavior to obtain a position in the market.

Thirdly, internal factors of the enterprise could also play a role. Plenty of factors existing within the enterprise also affect their environmental strategies. As a complicated organization, an enterprise is composed of staff, managers,

shareholders, and the board et al. These stakeholders have different interests, and consequently, bear different environmental pressure. Managers' environmental consciousness is crucial, and their tasks in directing environmental strategies include defining enterprise's prospects, mission, operating philosophy and targets, formulating innovative strategies, fostering environmentally friendly culture, setting up environmentally friendly organizational structure and training staff, and so on. Only under the guidance of managers' environmental consciousness, environmentally friendly organizational structure and environmental protection culture could be built up to realize environmental organization management and root environmental consciousness into the mind of staffs. Managers should make full use of opportunities to protect or improve environment, positively instill the concept of environmental protection into every department, and build an environmental culture. However, a survey has been delivered among the Chinese managers, and it illustrates that less than 1/3 of the managers think that they have a full understanding of relevant environmental laws and regulations, and majority of them have very weak environmental consciousness, especially SMEs managers. In addition, organizational structures also play a significant role in enterprise environmental strategies. Russo and Fouts (1997) argue that bureaucratic enterprises usually react passively to environmental problems, while organic enterprises tend to adopt positive preventive environmental strategies. Study of SMEs by Castka and Balzarova (2004) points out that the system structure of an enterprise (e.g. ISO 9001:2000) is an effective tool to assign the social responsibilities to the individual enterprises. Some domestic research also proves that enterprises with standardized management system like ISO 9000 are more positive in implementing environmental strategies. In China, organizational structure and system of SMEs are still incomplete, which, inevitably, seriously undermines the implementation of environmental strategies. Moreover, an analysis by a research group of Beijing Normal University implies that SMEs are still faced with plenty of barriers in the process of carrying out environmental strategies. Firstly, financial inadequacy is the most serious problem. Due to their small scales and limited strength, SMEs has seriously inadequate input to environmental protection. Secondly, backward technical support is another barrier. Lin Hanchuan et al (2001) have carried out a survey of among SMEs in Hubei and Guangzhou, and it reveals that the most of them still stay at the technical level of 1980s or even earlier. In recent years, new technologies with environmental consideration are seldom applied in majority of SMEs. The third barrier is related to incomplete policies and social service system of SMEs.

Enterprise environmental strategies are mainly restricted by the three factors stated above. Undoubtedly, these three factors are interactive and dependant to one another, which is shown in Figure 1.

IV. Selection of SMEs' Environmental Strategies

Comparatively speaking, factors like government regulations and market are uncontrollable for enterprises, while their internal factors are controllable. Since enterprises could hardly change their situation and behavior by working on the uncontrollable factors, the internal factors become crucial in implementing environmental strategies. However, it is still undeniable that pressure from both the government and market also affect the strategic choices of enterprises, although the former acts in a more direct way than the latter. Petts et al (1999) mention that scholars have already reached an agreement on the driving factors of business environmental performance, and point out further that

abiding by the relevant regulations and laws is them most essential one. For SMEs, controlling and managing power is far more influential than market power and social power. Due to the incomplete market economic system in China, SMEs are usually lack of long-term consciousness, and, as a result, have a slow reaction to market pressure. Furthermore, influence of Government regulations is decided by the pollution level of the enterprise and related industry, and in this sense, using enterprise strength and its pollution level as two dimensions, we have built up a matrix, which could have some implications for SMEs in selecting environmental strategies.

According to Figure 2, SMEs could adopt four strategies for their environmental management: sustainable development, proactive, compliance and adjusting.

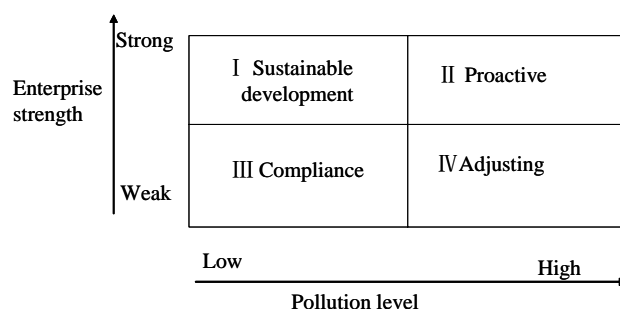


Figure 2. Environmental Strategies of SMEs

IV. 1 Environmental Strategy of Sustainable Development

Some SMEs with features of clear organizational structure, competitive products, advanced technologies and sufficient fund usually have strong enterprise strength and low level of pollution, and they are recommended to adopt environmental strategies of sustainable development. Thanks to the advanced technologies and environmental friendliness of their products, environmental protection standards of these businesses usually outperform the regulatory standards of government. These businesses are usually of high competitiveness, for example, clothing industry, and they are faced with no external environmental pressure, and it is a wise decision for them to concentrate on improving competitive advantage by their existing green advantages, and constantly expanding.

IV. 2 Proactive Environmental Strategy

Some other SMEs are characterized as having clear organizational structure, competitive products, but these products have relatively serious pollution due to some their specific properties or some technical factors. These businesses enjoy rapid development and certain scale, however, their development is at the price of consumption of resources, for example, chemical industry, and result in serious environmental pollution. Therefore, they are at the top list of government control. Due to the uncontrollability

of government regulations and market factors, these businesses are required to work on their internal factors, for instance, adopting new technologies, eliminating backward technologies with serious environmental effects, or relocating factories in the sparsely populated areas, and control their environmental effects to the minimum. This kind of strategy is "proactive environmental strategy". On the other hand, enterprises should be active to communicate and collaborate with the government, and obtain political support by political tactics. This strategy is tailored for those with strong strength but poor environmental performance, and with implementation of it, businesses could not only reduce their damage to environment, but also lower the unit cost of product, enhance internal strength and competitive advantage.

IV. 3 Compliance

Due to various individual strengths, environmental strategies of different SMEs businesses should have different emphasis. Without strong market power, advanced technologies, and large scale, some SMEs are at the beginning stage of development and of little negative environmental effect, such as small high-tech companies. Although Government's regulations have limited impacts on these businesses, they still should strictly comply with these rules, and then devote to expand and upgrade their strength. This is "environmental strategies to comply with". This kind of businesses should focus on solving bottleneck problems like financing,

shortage of human resources, featureless products and weak research ability.

IV. 4 Adjusting

Those with backward technologies, uncompetitive products, small organizational scale, and serious environmental pollution are the emphasis of government's control, such as some small paper mills. This kind of SMEs is at the edge of life-and-death, and they must positively adjust themselves, close some production lines with serious environmental effects, and introduce new technologies. However, in the case of lack of cash and human resources, they could consider cooperate with other large companies, and seek for further development. This is what we call "environmental strategies to adjust", which is usually accompanied by the integral strategic adjustment of the company, covering organizational structure adjustment, production technology adjustment, staff adjustment, and product type adjustment.

IV. 5 Benefits From Implementing of Positive Environmental Strategies

According to Bichta (2003) and Russo & Fouts (1997), implementing of positive environmental strategies can bring the following benefits to the company:

(1)Economic profits. Pollution means waste. Investments on new technologies can result in effective reduction of raw materials, improved operating efficiency of equipments and facilities, effective recycling and reuse of waste and reduction of operating costs, which would inevitably upgrade the economic profits of the organization.

(2)Reputation. Businesses could positively publicize their environmental policies to win reputation, which is undeniable competitive advantage. Therefore, SMEs in China should be aware that there are no conflicts between implementing environmental strategies, and positively shoulder the social responsibilities and economic profits.

Here, we propose four types of environmental strategies for SMEs: sustainable development, proactive, compliance and adjusting. However, it can not be inferred that a SME could have only a choice for these four environmental strategies to be applied in its environmental management practice. Moreover, in fact we think that these strategies can be utilized in the same SME during its life cycle, and the tactics contented in a strategy and their portfolios should be a continuous pedigree.

V. Conclusions

Environmental issues have become the focus of society. However, China enterprises have not paid enough attention to environmental issues, especially those of SMEs. In this paper, it points out that environmental issues of SMEs are imperative. On the basis of analyzing the restrictive factors, we puts forward four environmental strategies based on internal ability and the pollution degree of the enterprises and analyze each strategy in details. It should be pointed out that each environmental strategy has its corresponding

strengthens and weaknesses, and the tactics contented in a strategy and their portfolios should be a continuous pedigree. The further studies should focus on the structure and distribution of continuous pedigree of environmental tactics and its effect direction and intensity with respect to SMEs.

John Naisbitt, author of *Mega trends*, et al has raise the theory that the lager the world economic scale is, the more powerful SMEs are economically. A number of economists also state that with full potential, SMEs will play a main role in 21st century's economic development. At present, China's economy is at the turn of transformation, and SMEs are all faced with the problems of improving their ability to start a second undertaking as soon as possible, and to make full use of resources. However, increasingly rapid development of technologies and globalization of environmental problems do provide a perfect opportunity for SMEs, which requires that SMEs to get rid of their traditional short-term concepts, grasp opportunities, fulfill their social responsibilities, correctly work out and carry out environmental strategies, so that further development and growth could be achieved in the fierce competition.

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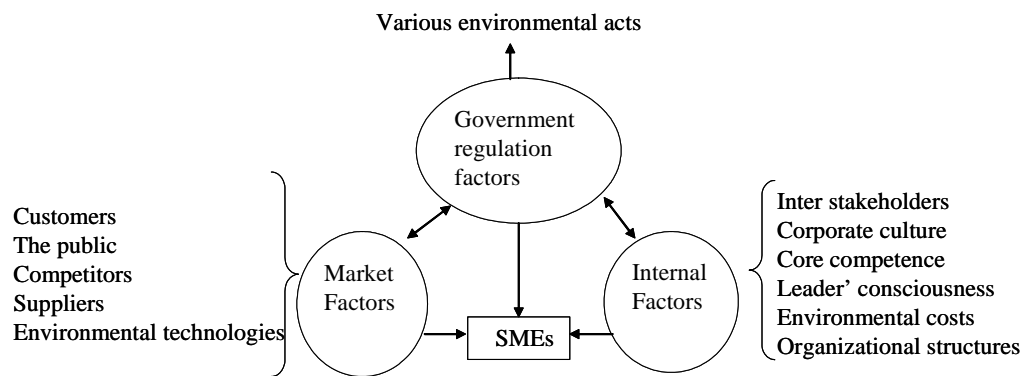


Figure 1. Restriction Factors of Environmental Strategies of SMEs

Value Chain Crossing Between SMEs and the Banking Industry

Daniel Beimborn¹, Sebastian F. Martin², Ulrich Homann³

^{1,2}E-Finance Lab, Institute of Information Systems, Goethe University, Frankfurt, Germany

¹Tel. +49-69-798 28839, ²Tel. +49-69-798 28805, ^{1,2}Fax: +49-69-798 28585

³Microsoft Corporation, Redmond, WA, USA

beimborn@wiwi.uni-frankfurt.de; smartin@wiwi.uni-frankfurt.de; ulrichh@microsoft.com

Abstract: What are future requirements for ERP solutions in small and medium-sized enterprises (SMEs)? The following research paper focuses on identifying interfacial areas between banking services and financial processes of SMEs. It should be possible for these services to be embedded into the information systems of SMEs in order to support their financial processes such as cash management, reconciliation, customer management and asset management in an automated, seamless manner. In this paper, we develop a framework and a methodology for our empirical explorative research, which are intended to be the foundation for investigating both financial processes within SMEs, as well as firms' willingness to adopt new services offered by banks. Furthermore, first results from four case studies indicate some promising results. But they also show particular problems from granting banks access to SME-internal systems.

I. Introduction

B2B integration of applications within the supply chain management has been a necessary requirement to stay in the market even for small companies in particular branches (e.g. the automotive industry) for many years. While similar trends could be observed in the financial services industry (such as outsourcing of IT and business processes as well as the inter-organizational integration of processes, which formerly were in the same firm), we want to turn around the perspective and to ask which financial processes can be insourced by banks (or other financial service providers) from small and medium-sized enterprises (SMEs). Which added-value services could a bank additionally deliver to SMEs, due to its position and competencies? These scenarios alike require a seamless integration of SMEs' business processes with a bank's service. Therefore, the investigation has to get an overview about the actual IS maturity of SMEs with the main focus on willingness and readiness to inter-organizational integration.

Presently, the financial services industry is intensively working on process optimization and modularization of processes, which leads to encapsulated services that cannot only be used within the financial firm but can also be offered to customers. A simultaneous investigation of existing or potential so-called value chain crossings (VCCs) on both sides (suppliers and customers: banks and SMEs) could give substantial insights into the future layout of an integrated market-oriented inter-organizational financial value-chain network.

One of our research goals is the identification of financial business functions (i.e., parts of business processes)

within business processes of SMEs, which can be more efficiently carried out by specialized financial service providers such as banks. The driving vision is that firms – especially SMEs, which typically lack specialized resources in certain financial domains like cash management – may profit from a bank's experience by integrating certain functions, which are offered and executed by the bank, within their own business processes. We refer to this linkage as *Value Chain Crossing* (VCC), i.e., a (financial) service provider's service seamlessly embedded within an industry partner's business process.

An old existing example which almost represents a VCC, but is not finally integrated in a seamless manner, is the EDI transmission of payment runs. Another example is the integrated Electronic Bill Presentment and Payment (EBPP).

The VCC definition matches with the service-oriented paradigm, where services can be plugged in and out within a modular business process landscape or may be even replaced by services from external vendors.

Our research questions thus are:

1. Which financial processes of SMEs offer the possibility for VCC with banks?
2. How do perceived factors like benefits, risks, external pressure, and technological readiness affect a SME's willingness to adopt new financial services, by integrating their systems with those of financial service providers?

For the first research question, we are developing scenarios for VCC between financial service providers and SMEs. Through explorative case studies, we examine whether or not these scenarios are regarded by managers of SMEs as viable.

For the second research question, we develop a theory-based framework of factors which might influence the willingness of SMEs to integrate with banks. We use this framework as a theoretical foundation for our explorative research of the VCC scenarios.

The remainder of the paper is structured as follows: after a short literature review in the following section, we depict the application domain of our explorative research and introduce our research framework. We describe the methodology for the empirical investigations before outlining the case studies we have conducted. In the last two chapters, we briefly discuss the results obtained so far, draw a conclusion and outline the further research.

II. Literature Review

VCC requires the appropriate enabling support on the technical layer. The set of technologies which carry out the integration between two or more organizations are referred

to in literature as Inter-organizational Systems (IOS). Cash and Kasynski [4] simply define IOS as “*an automated information system shared by two or more companies*”. Johnston and Vitale [19] refer to IOS as systems which are “*built around information technology, i.e., around computer and communications technology that facilitates the creation, storage, transformation, and transmission of information*”. In other words, IOS are the technological means by which application and, implicitly, business process integration of two or more firms are carried out.

Inter-organizational cooperation through IOS may occur in several forms [3]. For example, from the point of view of the participant's position relative to each other, horizontal cooperation takes place between organizations that act on the same level of the supply chain, i.e., between potential competitors. In contrast, vertical cooperation occurs between organizations that act on different levels of the supply chain. Finally, lateral (or diagonal) cooperation takes place between organizations that have neither a vertical nor a horizontal relationship [3]. In lateral cooperations, the use of IOS facilitates the appearance of electronic “*links between industries that were formerly separated*” [16].

VCC is a form of lateral cooperation. As Williams [26] states, “advances in the use of IOS entail greater interdependence between, and deeper systems penetration into, organizations”. According to him, “when [IOS] are used to alter the division of labor and to develop new forms of coordination and control between organizations, they penetrate more deeply into the affairs of each organization, as when one organization requires information via an IOS about work in progress in another organization” [26].

Large parts of literature discuss the issue of innovation adoption and diffusion within organizations. For example, the Technology Acceptance Model (TAM) [7] investigates technology adoption on an individual level, where users are free to choose whether they use the new technology or not. This theory identifies two perceived attributes as key indicators for the adoption of innovation: perceived usefulness and perceived ease of use of the new technology. The usefulness is a measure of “*the extent to which an application contributes to the enhancement of the user's performance*”, while the “*ease of use relates to the effort required by the user to take advantage of the application*” [7]. This model has been validated in many studies about technological innovation “*where individual autonomy is permitted to adopt or reject an innovation*” [15].

More suitable with the context of our research is Gallivan's Organizational Acceptance Model [15]. He criticizes about the TAM that in certain situations, where its underlying assumptions are not met, the TAM is likely to “*produce findings that are weak, unstable, or open to question*” [15]. Such a situation would occur when users of a certain technological innovation are mandated to use the new technology, which is adopted at organizational level.

There is a literature stream which focuses on process and stage research models, attempting to understand organizational-level implementation of innovations. In these

research models, the matter of interest is how extensively the innovation is used and how deeply the firm's use of the technology alters processes, rather than the user adoption and use of the technology per se [15]. The best-known model which describes technology implementation in organizations [15] is the six-stage model [5] [20]. The six stages of implementation are: (1) initiation, (2) adoption, (3) adaption, (4) acceptance, (5) routinization, and (6) infusion.

Our research concentrates on the first of the six stages named above. During the initiation stage, “active and/or passive scanning of organizational problems/opportunities and IT solutions are undertaken”. As a result, “a match is found between an IT solution and its application in the organization” [5]. For this phase, we investigate how the factors that we use in our research framework influence the willingness of decision-makers to adopt new financial services, by integrating their systems with those of financial service providers.

III. Research Domain and Framework

III.1 Research Domain

Our objective is to get an insight into the actual EAI and B2BI maturity of German SMEs as well as into the actual and possible integration of banking services into the financial processes of SMEs.

Cooperation is evaluated to be the most adequate strategy to ensure the survival of the German SME segment [3] [2] [25]. Nevertheless, many studies show that small companies use cooperation much less than larger firms. As (SME specific) cooperation inhibitors, insufficient ability and low willingness to cooperate were identified [3]. Helm et al. show that this low willingness often originates from the company's legal form [17]. Many SMEs are led by their owners, who set their primary goal on ensuring autonomy. Furthermore, this governance mode leads to a more risk adverse attitude, fearing the possibility of cooperation failure. Empirical studies showed that 30-50% of all cooperations fail [13]. Additionally, the lacking strategic orientation of SMEs is a reason for missing willingness to cooperate. Additionally, SMEs often are more risk adverse and fear the possibility of cooperation failures. Empirical studies showed that 30-50% of all cooperations fail ([13] (studies mentioned there)).

The first large empirical survey on internet-based cooperation of SMEs in Germany was conducted in 1999 [10]. The authors prescinded from particular business processes and investigated general cooperation activities and their impact on external business performance.

Due to increasing industrialization tendencies in the financial services industry, the aim of our study is to focus more dedicatedly on the cooperative support of the particular area of financial processes. These will not be part of the core business in most cases and might be a possible area of outsourcing (as a particular form of cooperation). Earlier surveys, which analyzed cooperation opportunities in the

SME segment, focused almost only on cooperation within the firms' value chains, and not on financial processes [10].

An empirical survey on large German firms showed rather high outsourcing potentials and even BPO activities in financial processes [23]. It has to be investigated whether this result can be transferred to the SME sector, or if SMEs' financial processes occupy only a minor fraction of the firm's resources, so that outsourcing will not lead to significant advantages.

Financial processes in our definition do not only cover the process of funds allocation and controlling, but also include all financial aspects involved with a firm's value chain, such as procurement and sales.

For our study, we developed a financial process map (see Figure 1), which structures an SME's financial functions into the process groups of Financial Trade Enablement & Settlement [23], Finance Management and Transactions Management. The Financial Trade Enablement & Settlement covers procurement and sales of goods and services, supported by managing the transactions infrastructure, while Finance Management embraces administrative financial functions.

For all financial processes, we investigate whether or not there are any VCC potentials, i.e., which process steps can be outsourced to banks.

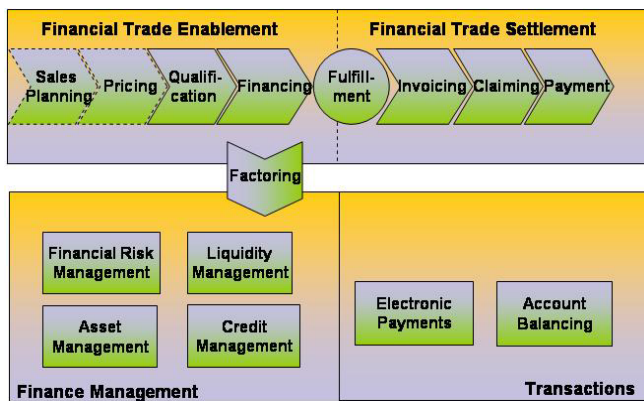


Figure 1. Financial process map of an SME

For example, during the enablement phase, banks could take over parts of the financial risk management, liquidity management, asset management, or credit management. During the settlement phase, opportunities for VCC could be offered by electronic payments or the account balancing.

III. 2 Research framework

Based on the EDI adoption framework of Iacovou et al., we have developed a framework of factors which we think have an influence on SME's willingness to adopt a VCC in the financial chain. Iacovou et al. [18] propose three factors which explain the EDI adoption behaviour of small firms: perceived benefits, organizational readiness and external pressure. We adapt this framework to our research domain, which is the VCC between SMEs and banks and add a further factor, "perceived risks", which might have an

important influence on the willingness of SMEs to adopt new financial services and thus to integrate with banks through IOS. The reason for considering this additional factor lies in the fact that, unlike EDI integration, as analyzed by Iacovou et al., where information is pushed to the integration partner, VCC implies the possibility for the bank to extract (pull) data out of SMEs information systems. SMEs might fear that, by adopting VCC, banks might get insights into the company's internal data that the company is not prepared to reveal.

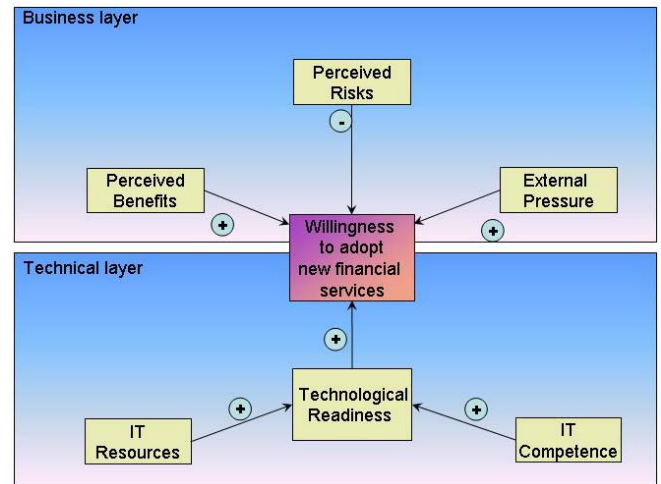


Figure 2. Research framework

Our framework is composed of the following factors:

Perceived benefits. The perceived benefits of adopting new IOS can be grouped into two categories. Direct benefits are "mostly operational savings related to the internal efficiency of the organization" [18]. The second group includes indirect benefits, like the improving impact that the implementation of new services might have on business processes and relationships [18].

Within our framework, perceived benefits refer to the benefits which decision makers within an organization believe will be generated by the integration of their own financial value chain with the financial chain of banks. While direct benefits of integration could be for example operational savings, indirect benefits could translate into a better rating of a SMEs creditworthiness and thus into better credit granting conditions, since the bank now has automated access to relevant data.

Because the framework offers an ex ante view of financial services adoption, the notion of perceived benefits refers to manager's expectations before any system implementation. They are thus "anticipated benefits" [18] and, as Iacovou et al. state, may differ significantly from the list of obtained benefits, provided by an ex post view.

A related term, "perceived usefulness", which also stresses out the ex ante character of this notion, is defined by Davis as "the degree to which a person believes that using a

particular system would enhance his/her job performance" [7].

Mehrtens et al. [22] also use the notion of perceived benefits to develop their model of factors which influence the internet adoption behaviour by SMEs.

We anticipate that firms that expect and recognize the benefits of optimizing their financial chain through integration with banks will be more frequently willing to adopt new financial services, than firms that do not expect benefits from such integration effort.

External pressure. In a study about IOS based on EDI, Crook and Kumar [6] identify three types of causal conditions for the adoption of EDI, where the first two terms can be subsumed under the notion of external pressure:

1. Customer-initiated EDI can be observed in vertically integrated industries, where large customers can force a firm to adopt EDI as an IOS.
2. Reaction to competition at organizational and industry level.
3. Organization-initiated use of EDI.

The notion of external pressure is also part of the framework developed by Iacovou et al., referring to "influences from the organizational environment" [18]. He sees the two main sources of external pressure to be (1) competitive pressure and (2) imposition by trading partners.

For our object of research, the imposition by trading partners or, using the terms of Crook et al., "customer-initiated" adoption, are not relevant, since we investigate the relationship between financial services providers (e.g. banks) and SMEs, with SMEs being the customers. But the external pressure as a "reaction to competition", or "competitive pressure" might play an important role as a determinant factor for the willingness of SMEs to adopt new financial services and thus to integrate with financial service providers. We believe this, because we think that the increased competition German SMEs have been facing in recent years will ultimately lead to optimization efforts even in secondary processes like financial processes.

Thus, we expect those SMEs that encounter external pressure from their competitors to optimize their financial chain will more frequently be willing to integrate with financial service providers, then those who do not encounter such pressure.

Perceived risks. Perceived risk is the "*felt uncertainty regarding possible negative consequences of using a product or service*" [12] and may possess several facets. Featherman identified seven facets of perceived risk for individuals, when confronted with the question whether to adopt new e-services, or not.

Decisions about VCC adoption on organizational level are taken by individuals and therefore, several of the seven risk facets described below also apply within the context of VCC. The seven risk facets identified by Featherman are:

1. Performance risk is "*the possibility of the product malfunctioning and not performing as it was designed and*

advertised and therefore failing to deliver the desired benefits" [2]. For VCC, performance risk means the possibility of malfunctioning IOS which would result into possible opportunity costs.

2. Financial risk is "*the potential monetary outlay associated with the initial purchase price as well as the subsequent maintenance cost of the product*" [19]. The current financial services research context expands this facet to include the recurring potential for financial loss due to fraud.

3. Time risk. Consumers may lose time when making a bad purchasing decision by wasting time researching and making the purchase, learning how to use a product or service only to have to replace it if it does not perform to expectations.

4. Psychological risk. The risk that the selection or performance of the producer will have a negative effect on the consumer's peace of mind or self-perception. Especially lack of trust is a very important matter when giving banks online access to company information.

5. Social risk. Potential loss of status in one's social group as a result of adopting a product or service, looking foolish or untrendy. We do not expect social risk to play a significant role in a B2B environment, since vanity is not a matter of interest when adopting VCC.

6. Privacy risk. Potential loss of control over personal information, such as when information about you is used without your knowledge or permission. In the case of the integration of SMEs with banks and granting them online access to firm data, managers of SMEs might feel that they are giving up control of the amount and the time of delivery of information to the bank.

7. Overall risk. A general measure of perceived risk when all criteria are evaluated together.

We expect all risk facets except for the social risk to influence directly managerial decision-making about the adoption of VCC.

Technological readiness. This term is derived from Iacovou et al.'s notion of "organizational readiness". In their view, the organizational readiness has two dimensions: the technological and the financial readiness. For the adoption of new financial services we assume the latter to have a rather insignificant relevance, because this kind of services would never justify huge investments. Financial efforts instead are captured in the construct of perceived benefits.

The technological readiness itself has, again, two dimensions: the level of IT competence within the organization (in terms of people and know-how) and the IT resources (in terms of hardware and software). The more knowledge, IT specialists and IT resources a company possesses, the higher its "level of sophistication" [18]. Iacovou et al. state that "*sophisticated firms usually are less likely to feel intimidated by the technology, possess a superior corporate view of data as an integral part of overall information management, and have access to the*

required technological resources (i.e. hardware, expertise, and a competent project leader)”.

In the case studies, we addressed the factor of technological readiness by asking managers if they have ERP, EAI, and CRM solutions implemented within their organizations and what types of IOS, if any, they use when exchanging data with business partners.

We expect firms with a higher technological readiness to be more willing to adopt new financial services than firms with a lower technological readiness.

IV. Methodology

Our research is divided into two phases with different objectives. The first step consists of conducting multiple interview-based case studies with a mainly explorative orientation. Objective is to get an insight into the actual EAI and B2BI maturity of German SMEs as well as into the actual and possible integration of banking services into SMEs' financial processes and the associated benefits and risks. The relationships between IT-based integration readiness and already existing VCCs should be explored. Further, the interviews will be used to identify possible new VCC scenarios, i.e. which additional financial services could be offered by banks and therefore should be integrated into the SME's process landscape.

In the second step we will conduct a questionnaire-based survey to validate the results and to evaluate the potential benefits and risks which are associated with the VCC scenarios that have been identified in the case studies. The questionnaire will not only focus on SMEs but also incorporate banks as supply-side.

The research questions given in the introduction are of a *what* or a *why* type¹. Case study methodologists suggest exploratory case studies to answer this kind of questions and to develop theories which can be validated in a following step by other research methods [8] [27]. Our case study design considers the attributes which Dubé and Paré identify as evaluated necessary by most of the case study methodologists [8] such as Benbasat [1], Eisenhardt [9], Lee [21], and Yin [27]. They claim for a clear a priori definition of the research questions, the constructs, and the unit of analysis. Further, a pilot case as well as a multiple-case design are recommended and realized. The attribute of literal replication logic is only partly met, because on the one hand the research domain is quite broad and unexplored and on the other hand the primary goal of the first phase (= case studies) is to collect information about the current state of B2BI readiness in different branches and to develop possible VCC scenarios.

Interviews have been the primary data source of our case studies. Besides that, company reports were consulted. From the framework development we derived an interview guideline which captures the constructs which have to be

instantiated to each of the investigated financial processes (Figure 1). For the first (“pilot”) case, the interview was conducted by three researchers (instead of two in later interviews) and the interview guideline was partially redesigned based on these first experiences. Furthermore, the guideline has been marginally refined after every of the following interviews.

The interview guideline consists of two parts. In the first part, we are asking for general information about the company and the interviewee, as well as about the company's information systems infrastructure and its relationships to banks (how many bank relationships, how many accounts, etc.) and other financial service providers. In the second part, for a subset of the financial functions presented in Figure 1, six VCC scenarios have been developed, in which a bank could take over the whole or a particular part of each function by integrating his service with the SME's information systems. For each of these scenarios, we discuss the potential benefits, involved interaction and integration efforts as well as potential risks and external pressures that might affect SMEs to adopt the VCCs. These constructs represent the upper part of our framework, while the technical layer would form the same prerequisite for all scenarios.

For collecting the cases, we used a regional SME database and selected 50 firms which fulfilled at least 2 out of the 3 “medium size” criteria of the European Union in 2004. Medium-size companies are defined as companies which have between 50 and 249 employees, a turnover between 10 and 50 Million EUR, and a balance sheet total between 10 and 43 Million EUR. The reason why we only chose medium-size companies in the first step (instead of small *and* medium-size), was that for developing hypothetical VCC scenarios, a quite well developed and (more or less) process-oriented IS infrastructure should be present within the company, which would allow the embedding of external services offered by a financial service provider.

The main branches we focused on during the selection process were Manufacturing, Trade and Repair Services, Real Estate/Renting, and Construction (following the NACE classification of the EU [11]). These four branches cover 88% of the German medium-size enterprises [14]. After the list was finished, the companies were called by phone and the managers responsible for the majority of financial processes were identified. Because SMEs have a quite small management, each time this person could be identified clearly and easily. After an initial mailing which explained our aims, these managers were called and asked for participation. Six out of the 50 managers agreed in taking part in a 2-3 hours interview. Up to today, four of these case studies have been realized – unfortunately only in the manufacturing sector, so far. The first results will be presented in the following chapter. After collecting at least six further cases, the case study results will build the base for the design of the next phase of our research, which will be a questionnaire-based survey for evaluating the VCC

¹ Even the 2nd question actually is of a *what* type (reformulated: “what is the present state of maturity...”)

scenarios with 700 SMEs as well as with about 300 banks.

V. First Cases

V.1 Case Study Participants

In this section we describe the firms which took part in our first case studies. To ensure anonymity, we chose fictive names.

PlastiCo is a private limited company with a family-owned majority of shares. It produces finished and semi-finished plastics goods (plastic in primary forms, plastic plates, sheets, tubes and profiles) and sells them to 800-900 established business customers located worldwide. The company has 110 employees, out of which about 75% work in the production while 25% work in the administration. The company's turnover in 2004 was about 23.5 million EUR.

In 2004, PlastiCo was forced to start insolvency proceedings that could finally be solved through consolidation and recapitalization measures. Due to this episode, the company's explicit strategy in the financial field is to maintain its independency from banks. Also because of this incident, PlastiCo currently has to pay most of its suppliers in advance, while it usually grants payment targets of 30 to 90 days to the customers. For this reason, PlastiCo's liquidities usually oscillate around zero. Our interview partner is head of IT and controlling with PlastiCo.

LacquersCo is a family-owned enterprise founded in 1917, which produces lacquers for the interior. It serves customers that range from wholesale customers to big retail store chains to craftsmen to do-it-yourself customers. In the B2B sector, the company counts about 1000 business customers. LacquersCo has 240 employees out of which about 55% work in the production while the rest works in the administration. Business figures like the company's annual turnover were not communicated by the interview partner. He occupies the position of a controller, factually responsible for all financial processes, reporting directly to the board of directors.

VacuCo was founded 1994 and is currently owned by an equity fund. It produces huge vacuum equipments for the metallurgic and automotive industry. Due to the nature of their product, they only sell about 60 to 70 complete installations each year. For the spare part business, the company has about 2,000 to 3,000 worldwide customers, all of them being big metallurgic or automotive companies. VacuCo has 268 employees and has achieved in 2004 a turnover of 74 million EUR. Our interview partner is head of the finance division, responsible for all financial processes at VacuCo.

CosmetiCo is a cosmetics company owned by a large corporation. About 85% of its products are sold to the owning corporation; the rest goes to about 7 to 9 worldwide customers, all being large companies. CosmetiCo has 230 permanent employees, out of which about 100 work in the production while the rest is working in the administration. Each year, the company hires about 80 to 160 additional workers for the Christmas season. In 2004, the company has

reached a turnover of 67 million EUR. Our interview partner was the chief of administration at CosmetiCo, in charge with all financial processes.

V.2 Units of Analysis

As units of analysis we chose six different (potential) VCC scenarios, which are linked to different financial functions in the process map (Figure 1). As mentioned before, goal of the case studies was to get first evaluations of these scenarios and to develop new ones, together with the interviewees, which have a huge expertise on SMEs' financial processes. The six VCC scenarios are shortly summarized in Table 1. Some of them do not represent new business models. Nevertheless, they are still not realized by VCCs according to our definition, i.e. by an inter-organizational integration of the relevant information systems.

The IT infrastructure of the case study participants, which would form the foundation for implementing a VCC, is briefly described in Table 2. During the case studies, the focus was on the use of inner-organizational and inter-organizational systems.

V.3 Case Study Results

In the following, we restrict the presentation of our first results to the two VCC scenarios of customer management (CM) and liquidity management (LM).

VCC scenario Liquidity Management (LM). The LM scenario describes the transfer of cash balancing tasks between multiple accounts (and possibly between multiple banks) from the SME to a bank.

The four study participants have between 2 and 21 bank accounts at 2 to 4 banks. All firms check their accounts manually at least once a day. VacuCo uses a cash pool account to manually balance its 21 accounts each day, based on liquidity requirement analyses.

VacuCo stated that outsourcing the liquidity management would be possible and very interesting. The same was assumed by the other firms for the hypothetical case, that they would have more accounts. Presently, these firms spend quite little efforts on cash balancing. Risks from granting one bank access to all of the firm's accounts were seen as low, except by PlastiCo, which made some bad experiences with banks before and during its insolvency phase.

A capital club between different firms is seen partially as interesting and partially as not practicable due to security reasons. Nevertheless, both firms that are subsidiaries of a corporate group (VacuCo and CosmetiCo) take part or will take part in a corporate cash pool program, where the corporation balances the liquidity of the different members, using an internal interest rate for allocation. The results are summarized in Table 3.

VCC scenario Customer Management (CM). The CM scenario describes outsourcing of customer-relevant financial processes, such as qualification, payment control, dunning, and customer portfolio analyses. By granting the bank access to customer-relevant data the bank can apply its

capabilities of rating etc. and use its information about the SME's account transactions to control incoming payments etc. The scenario was only discussed with three of the case study partners, because CosmetiCo makes most of its business with its parent company and has only very few customers. None of the firms mentioned problems with bad payment behavior and all wanted to protect their customer relationships. Following, no firm would outsource dunning and only one firm would perhaps grant a bank access to customer data for portfolio analyses while the interviewee could not believe that the customers would agree with releasing data about them. The results are presented in Table 4.

Beside a first evaluation of the six initial scenarios, a major issue was to identify new scenarios, which could be evaluated in further case studies and in the questionnaire-based second phase of the project. A first scenario which was developed during an inter-view was a firm's need to get Basel II support, i.e. SMEs would open their systems to banks for getting better ratings and for getting advice to optimize their business figures when applying for loans.

VI. Discussion

The presented results of our first case studies show only preliminary findings of our research. Nevertheless, they indicate potential VCCs, as well as the problems involved. It was not goal of this paper to show a representative picture of the German SMEs' attitude to adopt VCCs, but to present the research approach and to discuss its appropriateness for answering the research questions introduced in the first section. The choice of a research domain which rather does not exist in practice, yet, was the main motivation for adopting a two-phase approach (case studies and questionnaire). Our first case studies may not be representative for the German SME sector and even for their particular industry, but they helped to get first insights into the feasibility of the developed VCC scenarios and the problems involved with them. When acquiring the next case study partners, we will more strongly focus on branches which have not been included so far (esp. trade and service companies). Nevertheless, case studies are never the appropriate approach to provide a representative picture in such a broad research domain and are even less appropriate to do explanatory research. The case studies showed that, besides the type of industry, there are a huge number of factors which might influence VCC adoption within the different financial processes (e.g. the firm's liquidity situation, governance mode, type of customers, geographical operating range on supplier and customer side, prior experiences with banks etc.). An explanatory research model would have at least to cover all of these parameters as control variables, while an exploratory research approach uses the model to structure the search for concrete drivers and inhibitors.

The case studies also neglected the supply-side view. The question how feasible a VCC scenario would be from a

bank's point of view again will be part of the questionnaire-based research. Of course, the step from determining the basic possibility of implementing a VCC to designing an effective business model, which will lead to bilateral adoption, is critical. Nevertheless, the competitive pressure in Germany enforces banks to look for new business opportunities and markets. Following Porter, innovative and sophisticated products are a possible strategy to achieve competitive advantages [24].

VII. Conclusion and Further Research

Main goal of this paper was to develop a research framework and a methodology which allows investigating the interfacial area between banking business and SMEs' financial processes. Additionally, some first case study results, which finally will form the first part of the research project, were presented.

The research framework interlinks the constructs of technological readiness, perceived benefits and risks, as well as external pressure regarding the adoption of novel embedded banking services into an SME's application landscape.

First results show some promising VCC scenarios, but also uncover the problem of granting a bank access to internal data, esp. if customer information is involved.

As a next step, we will conduct more cases in other branches (esp. trade), following the proposed methodology. After this, phase II will follow, which comprises an empirical survey with 700 SMEs and the German Top-300 banks (for also evaluating the developed scenarios from "supplier side"). Afterwards, a more technical part of the project will make sample implementations of promising VCC scenarios, together with partners from the banking industry, from the software branch, and from the SME sector. In this manner, we will hopefully be able to make a theoretical (assessment framework for embedded financial services) and a practical contribution (prototype implementation of VCCs) to the emerging domain of value chain crossings between banks as financial service providers and the SME sector.

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Table 1. First VCC scenarios

VCC scenario (abbr.)	Related financial function	Description
Bank reconciliation (BR)	Invoicing, payments	The bank takes over all tasks for digitally mapping bank vouchers to internal accounting vouchers.
Liquidity management (LM)	Liquidity management	SMEs often hold multiple bank accounts for different reasons. If one bank has access to all accounts and at the same time is granted access to particular internal systems of the SME, it could take over liquidity balancing. By considering planning data, liquidity balancing could be done more effectively and future-oriented. The scenario could be extended to a capital club, where the liquidity balancing could be done over the accounts of multiple small firms, which trust each other (e.g. within a regional context).
Customer Management (CM)	Qualification, claiming	The account holding bank has information about incoming payments from the SME's customers. By granting the bank access to additional customer and invoice data, it could control incoming payments, perform dunning, check creditworthiness as well as perform customer profitability and portfolio analyses (customer-based business intelligence)
Factoring (FO)	Factoring, liquidity management	Factoring means an ongoing purchase of receivables through a financial institution. These institutions adopt the risk of default and all collection and dunning issues. At present, factoring is mainly offered by specialized companies. The VCC scenario includes a factoring community under the patronage of a bank, where different companies join to sell/purchase receivables to/from each other. The bank provides claim rating, control, and mutual trust.
Financial risk management (RM)	Financial risk management	If the bank is granted access to particular systems of the SME, it can provide financial risk management capabilities to the bank, much more easily. Depending on the SME's kind of business this could be factoring risks, interest risks, and currency risks.
Asset management (AM)	Asset management	Because a bank possesses superior knowledge regarding different types of asset products and of the capital market, it could overtake all tasks related to asset management, if a SME had sufficient cash funds to do sophisticated asset management (more than overnight money).

Table 2: Information systems infrastructures of case study partners

		PlastiCo	LacquersCo	VacuCo	CosmetiCo
Enterprise Resource Planning System (ERP)	Product	SAP R/3	TWS	SAP R/3	ABAS ERP
	coverage of all processes	80-100%	Unknown	40-60%	80-100%
	coverage of financial processes	60-80%	Unknown	80%	80-100%
Customer Relationship Management System (CRM)		Covered by R/3	None	Covered by R/3	None
Internal systems integration (EAI)		None	None	SAP connectors	None
B2B integration		EDI covers 20% of all communications with automotive customers.	EDI covers about 30-40% of total business document exchange.	No integration. Only classical media (fax, mail) and email.	No integration. Only classical media (fax, mail) and email.

Table 3: Case study results on VCC scenario "Liquidity Management"

		PlastiCo	LacquersCo	VacuCo	CosmetiCo
Demo graphics	Number of bank contacts	3	3	4	2
	Number of accounts	3	3	21	2
Perceived benefits	Actual efforts, which could be reduced by outsourcing.	Rather low efforts; manual transfer of data into ERP; accounts are checked 3 times/day. Scenario was evaluated as interesting for more accounts	Rather low efforts, once per day accounts are checked. For more accounts, this scenario was evaluated as interesting.	High efforts; cash pool account is used for manual cash balancing, based on liquidity requirement analyses.	Low efforts, but in the past it was planned (but not realized) to create more accounts for foreign currencies and to outsource the balancing over those accounts.
	Integration and interaction efforts	Perceived as low	Perceived as low	Perceived as low	In the past, the VCC scenario could not be realized due to incompatible systems between the banks.
Perceived risks	Risk from granting one bank access to all accounts	Medium, due to own experiences before and during the insolvency phase	Low, would be no problem	Low, would be no problem	Low, would be no problem
	Risk from granting a bank access to additional planning data, etc.	Too high	Too high	Medium, would be realizable	No problem
	Risk from joining a capital club	Medium, a committee would have to be implemented	Rather high	Too high	Rather high, but will be implemented within the corporate
External pressure	Competitive reasons for outsourcing	None	None	None	None
	Others			Corporate forces subsidiaries sometimes to grant credits to other subsidiaries (bilateral contracts)	From Aug 2005 all subsidiaries will take part in a corporate-wide capital club, where liquidity is balanced daily

Table 4: Case study results on VCC scenario "Customer Management"

		PlastiCo	LacquersCo	VacuCo	CosmetiCo
Demographics	Number of customers	800-900 established clients, 3,000 customers in total	1,000	2,000-3,000	8-10
	Number of outgoing invoices	12,000 per year	62,000-84,000 per year	3,150-4,150 per year	1,500-2,000 per year
	Customers' payment behavior	<1% of all invoices are not paid, a few customers claim every invoice for stretching the payment target	Almost no problems	0.03% of all invoices are not paid, <1% reclaimed	No problems
Perceived Benefits	Actual efforts, which could be reduced by outsourcing.	Customer management (<i>qualification and portfolio analysis</i>) is already outsourced to a specialized service provider which offers an extensive added value. <i>Dunning</i> is done internally, outsourcing would not make sense, because there are no scale effects.	<i>Qualification</i> is done internally. External information is requested manually. <i>Portfolio analyses</i> are done internally. Benefits from outsourcing are estimated to be rather low. <i>Dunning</i> is done internally.	<i>Qualification</i> is done internally. External information is requested manually. <i>Customer portfolio analyses</i> are not needed (one-off business). <i>Dunning</i> is executed automatically by R/3.	Scenario was not discussed, because 85% of CosmetiCo's business is done with its parent company.
	Integration and interaction efforts	Perceived as rather high. Too high for outsourcing dunning.	Perceived as very high.	Perceived as very high.	
Perceived Risks	Risk from granting a bank access to customer data	High, but controllable	Too high	Too high	
	Risk from outsourcing dunning	Too high	Too high	Too high	
external pressure	Competitive reasons for outsourcing	None	None	None	

The Impacts of Liberalization and Privatization in Taiwanese Electric Industry

Ming-Yuan Cho Jung-chin Chen Jong-ching Hwang
Electrical Engineering Department
National Kaohsiung University of Applied Sciences, Taiwan
a092304104@cc.kuas.edu.tw

Abstract: Taiwanese electric industry with liberalization has been a rapid change in the management style and the working environment. The change of the working environment has made a notable impact on the working conditions and the job security of the employees. This paper presents a brief literature review of the influences of liberalization and privatization on workers attitudes and proposes six overarching factors of importance to workers. These factors are: (1) the safeguarding of workers' rights and interests (2) compensation of potential loss (3) communication (4) leadership trusts and employee consultation (5) participation of employees and the labor union (6) encouragement to learn and to cultivate a second specialty. These factors are developed as a framework which could serve to help decision-makers and leaders with useful strategies in the privatization process.

I. Introduction

Liberalization is occurring very quickly in many countries throughout the world. In contrast to decades ago, when privatization was discussed but only a few industrialized countries were actively promoting the concept of privatization, the rationale for privatization is now widely accepted. It is perceived that State-owned enterprises (SOEs) have not met consumers' needs well and the records of SOEs have become worse and worse [18].

Privatization, in short, is the process of transferring productive operations and assets from the public sector to the private sector. Broadly defined in this fashion, privatization is much more than merely selling an enterprise to the private highest bidder. Privatization includes a wide range of approaches like contracting out, leasing, private sector financing of infrastructure projects, liquidation, and mass privatization [22].

Taiwan Power Company (TPC) face the great impacts and organizational change (OC) brought by privatization, liberalization and globalization. Privatization inevitably entails significant changes in the management style and the working environment and hence has a masked impact on the working conditions and job security of the employees. Clearly, privatization policy has many social and economic impacts. Thus, even though privatization of SOEs has become the major trend of development for many countries in the world, the promotion of privatization can easily incur strong resistance.

In Taiwan, in view of the great changes in the domestic

economic environment, the policy goals of the government's privatization efforts have been reset to put emphasis on building competition across all industries and promoting the allocation efficiency of social resources. Despite the slow progress of privatization in its first several years, the government has set privatization as one essential part of its current deregulation drive, and there is no doubt that the government will fulfill its privatization commitment and introduce competition into all markets [3].

Although the strategic policy of privatization is clear, it is to beneficial to everyone involved that the process can be undertaken without disruption and disharmony.

II. Liberalization and its Pproblems

II. 1 Delay in Deregulation

Liberalization and privatization in industrialized countries has generally centered on denationalization or privatization in a narrow sense. In the UK privatization and deregulation has occurred more widely, linked to broad micro-economic reform. Generally in the developing world and in East Asia privatization has made very slow progress.

This does not mean that deregulation is not necessary in other countries or that the regulated part of the economy is small in other countries. It is said that 40.9 percent of all industries in Japan were regulated by the Government in 1993, while in the USA sectors subject to regulation were reduced from 28.9 percent in 1980 to 23.3 percent in 1992 in terms of their contributions to total gross domestic product [10].

There are number factors that can give impetus to deregulation. First, conditions for the Government to take leadership for deregulation must be present. For example, deregulation must be made an issue of policy during elections. Second, managers in regulated industries must change their dependence on government regulation and be encouraged to do business on their own account. They must recognize that this is for their own interest in the long run, that there will be expansion of business under deregulation. Third, there must be a deregulation principle law to give a legal basis to the idea or principle of deregulation and to prevent its mutilation in implementation.

For a long time, TPC has been operating in a bureaucratic fashion and workers' rights could be considered to have been overprotected and generous compared to other parts of society. When facing the impacts of privatization, employees feel that their working capability is threatened and thus reject organizational reform. They do not believe in the commitments of the owner [1]. A management crisis is

precipitated by privatization of SOEs.

Reflecting the public consensus reached at the National Development Conference (NDC) held at the end of 1996, the Taiwanese government vowed to expedite the privatization of SOEs. Accordingly, the CEPD completed a review of the timetable set for 47 SOEs to be privatized by 2003, and steered through modifications of the regulatory legislation to facilitate the privatization process. However, the government has encountered some delays in the course of privatization due to: (1) Legislative logjam (2) Labor opposition (3) Resistance from Taiwan's Provincial Governments.

There are four main reasons why the privatization program of Taiwanese public enterprise is often behind schedule [3].

1. Workers and labor union resistance change.
2. Political interference in the privatization process.
3. Legal restrictions on business scope.
4. Financial restrictions in public enterprises.

In Taiwan, privatization cannot be viewed as a pure economic policy or a policy option [3]. Instead, it contains substantial social meanings and consequences.

II. 2 Effects of Liberalization

As has already been mentioned, privatization has meant a change in management style and working conditions. The distinctions are summarized under six headings, and it is in terms of changes in these characteristics that privatization or quasi-privatization can be expected to impact on performance [14]. The six characteristics are: goals, management, labor, communications and reporting systems, organizational structure and nature and location of the business. The change of the working environment has made a notable impact on the working conditions and job security of the employees.

The Taiwanese experience has several practical and theoretical implications. First, there should be clear policy objectives of what privatization is expected to achieve. Given Taiwanese economic and technological context, liberalization and privatization were implemented to prepare SOEs for global competition and technological challenges, and to stimulate the stock market. In other countries privatization may be carried out due to fiscal and efficiency considerations. As in general it is important that efficiency improvements should be the primary goal of privatization [7].

Second, the approach to privatization should reflect the policy objectives of the state. In Taiwanese case, there was a well-planned, phased approach which involved gradual liberalization, as well as increased regulation to ensure high levels of quality and service, within an approach described as "managed competition" [16]. In other contexts, "shock-treatment" and further deregulation may be desirable.

Third, the Taiwanese experience is consistent with the proposition that privatization is more successful if it is carried out within a well-developed institutional and regulatory context. Privatization of both competitive and

noncompetitive SOEs is easier to launch and more likely to yield financial and economic benefits in countries that encourage entry and free trade, offer a stable climate for investment, and have a relatively well-developed regulatory and institutional capacity [7]. The existence of such a context in Taiwanese has aided SOE's privatization and subsequent performance.

Fourth, the state should give its full commitment to the privatization process within a well-planned framework for action. Political authorities gave their complete commitment and support to the privatization effort, ensured the integrity of the process, maximised transparency and reduced discretionary decision making by individuals involved, all of which are deemed as key success factors in privatization programmes [4].

Fifth, the SOE should receive prior preparation for privatization. The means to do so vary, and should depend on the industry context and the state of the enterprise. In Taiwan, for example, the gradual introduction of "managed competition" was deemed necessary, while in other contexts efficiency improvement measures may be warranted, such as bringing in private managers who should be given autonomy as well as held closely accountable for performance [4].

Finally, the dominant view that government ownership leads to inefficiency should be reconsidered, in the light of the Taiwanese experience. Clear government policies relating to the pursuit of globally competitive standards of quality and service, a civil service recognised for its efficiency, meritocracy and pragmatism [5], as well as clear competitive strategies and focus on efficiency at the SOE level have led Taiwanese SOEs to world-class performance.

It can be argued that the Taiwanese context is not typical of other countries' situations. Taiwan is a small, resource-lacking island-country, but has exhibited clear long-term development strategies at the national level as well as an efficient civil service and a highly skilled workforce. Taiwanese experience with SOEs, however, does indicate that it is possible to achieve world-class performance under government ownership, given certain contextual conditions. The gradual privatization and liberalisation processes, coupled with "managed competition" used in SOEs, moreover, have significant practical implications for the implementation of privatization programmes which may be useful in a variety of contexts.

Government's sales policy in stock market

In the UK, the Government gave favorable treatment to buyers of shares and assets which were state-owned. Consumers buying BT shares in 1984 were offered a choice between vouchers to reduce their telephone bills or one bonus share for every ten still held by the end of November 1987, three years later [15]. The Housing Act of 1980 in the UK gave people who live in state-owned houses the right to buy them at a radical discount. But in Japan there was no favorable treatment to buyers at all. The Government thought it unfair to treat buyers of shares of privatized assets favorably because the assets were national property

originally. The telecommunication market in Germany, there is no special rights for the government as stockholder, no "golden share".

In Japan privatized enterprises did not give any favorable treatment to their shareholders, while in the UK, for example, BT shareholders were given bonus shares or reduced telephone charges, as mentioned above. The Nippon Telegraph and Telephone Corporation (NTT) shareholders were given 0.02 bonus share for every one in November 1995, but this is far from favorable treatment because of the small quota and a severe slump in the stock price [18]. There has been no reduction of the telephone bills for shareholders.

In the UK, privatization led to a high degree of worker participation and workers have obtained shares at a discount or with the assistance of interest-free loans [19]. The same can be seen in social denationalization in West Germany in 1959-65 [8]. But in Japan employee loyalty is high, so there seemed no need to try to enhance it with employee share schemes.

Employee Resistance Organizational Change

When facing changes to the *status quo*, some people perceive that the proposed is against their vested interests, others are afraid of the uncertain consequences; both groups will therefore resist the reform. Employees' psychological reaction and attitude depend on their understandings of the reform, their experience and their current social relations. Although likely to be more complicated in reality, reference [17] categorized responses to change into three categories:

- Aggressive support,
- Neutral observation and
- Resistance.

It is the latter of these responses that is the focus of the work in this portfolio, although doubtless their some mutual dependence among them. Reference [11] had noted that resistance is commonplace, thus workers' attitude is one of the keys for organizational reform. In [17], define resistance as the actions taken by members of an organization to reject the objective or policy of the organization. Members refuse to achieve the objective, or try to avoid carrying out requests from the organization. Reference [1] believes that it is vital to find out why workers resist against organizational reform during the process of privatization. On the basis of research he concludes that workers usually resist against organizational change for the following reasons:

1. Potential economic loss.
2. Potential social loss.
3. Adjustment.
4. Lack of Respect.
5. Misunderstanding

Reducing Resistance from Workers

Guidance for the implementation of change comes from many sources. Reference [2] found that the following approaches can reduce resistance against reform:

- the initial introduction of small-scale, modest reform,
- the extensive use of education and demonstration,
- the planning and implementation of staff participation.

In an overlapping set of suggestions, which importantly identifies specific attention to dealing with the emotional status of participants, Reference [20] suggested:

1. When participants of reform are familiar with the values and ideals of the plan of reform;
2. Allowing affected personnel to participate in the plan of reform;
3. Full support from the high-level managers;
4. When participants of reform believe that the reform can reduce their workload;
5. When participants are interested in the plan of reform;
6. When participants of reform do not need to worry about their independence and security;
7. When participants have consensus towards the importance of reform;
8. Let participants act together;
9. Understand the feelings of the participants and reduce unnecessary fear;
10. Full communication and question clarification;
11. Establish mutual trust among participants and
12. Increase usefulness by public discussion.

A condensed but wide ranging set of practices was also suggested by [9]. These approaches to resistance reduction should be used concurrently and intelligently. That is, managers should use various strategies; understand the advantages and limitations of each method and to communicate according to the actual situation.

(1) Communication

Consultation has various functions that include emotional relief, advice, reassurance, negotiation, clarification, and re-education. Communication can help to let workers understand the necessity of reform and to reduce their resistance. Leaders can use one-on-one discussion, group briefing, education and training to communicate with workers and to publicize the notion of reform. Participants in organizational reform should inform as early and as clearly as possible about what is involved. Effective communication allows workers to receive relevant information, and also gives them opportunity to raise questions and receive satisfactory answers. A feedback system is thus established.

(2) Participation and Involvement

The involvement of potential rejecters in decision-making can not only reduce potential resistance but also increase the quality of policies. In [21], also holds that in organizational reform, participation of workers is vital for the morale and for the relations between workers and the management. Moreover, participation is a form of communication, by which workers can understand why reform is needed. Reference [13] believes that recognition, emotion and action are the three important features of participation that can

create active reaction for observation and judgment. Through participation in the decision-making process, workers feel that their comments are respected and hence their resistance to organizational reform can be reduced. Participation and involvement can take many forms and may include the use of team and group process to involve worker at all levels in planning the future. As well, reward schemes for positive suggestions about improved processes can work.

(3) Facilitation and Support

Reform promoters should use various supportive activities to reduce resistance from workers. When employees feel worried or anxious, leaders can use employee consultation, psychological consultation and new skill training to assist workers adapt to the new situation.

(4) Negotiation and Agreement

Certain rewards are needed to reduce resistance, such as to include certain employees who have influence.

(5) Manipulation and Cooperation

Manipulation means to reduce the impacts of reform, to twist the resistance and to set up a favorable environment. Cooperation refers to comprehensive strategy and multiple military tactics, which is related to controls and participation. By giving the leader of the resistance party an important role to play, members who reject reform would participate in the decision-making process and thus are involved.

(6) Explicit and Implicit Coercion

Put pressure on the rejecters to force them to accept the decision.

The above-mentioned six methods should be used simultaneously and intelligently to ensure successful reform of the organization.

In summary, six dimensions emerge a crucial to the privatization change process. Briefly again, a number of studies have suggested that *safeguard of workers' rights and interests* have a significant impact on workers in privatization [1] [15]. Also studies have indicated that *compensation of potential loss* have positive effects on workers' commitment [1]. In relation to *communication*, it has been found that the effects of workers were positively correlated with successful organizational change [1] [9] [21]. In most previous studies, measuring effects of change on *leadership, trust and employee consultation* has been used [1] [9] [13] [21]. Previous studies have all related *participation of employees and the labor union* with successful privatization [1] [13] [21]. The relationship between reducing workers' resistance and *encouraging the learning of a second specialty* has been examined by [1] [9] [13] [21].

Notably, the research which provides the foundations for the establishment of these six dimensions to managing resistance is drawn from research down in western societies and it is not clear how these relate to the situation which exists in modern day Taiwan which has a Chinese but also

has important Japanese and American influences as the result of occupation and strategic alliances. The intent of the remainder of this paper is to develop an instrument which effectively taps these dimensions within a Taiwanese organizational context in which the threat of privatization is real.

III. Research Methodology

A survey instrument encompassing the six dimensions described above was developed. This contained 30 items taken from various appropriate sources. Twelve items on workers interests were drawn from a survey instrument developed by the Taiwan Power Company. Thirteen questions were drawn from a privatization questionnaire developed by the Taiwan Council for Economic Planning and Development (CEPD). The remaining five items addressed the regulation of workers' rights.

Each item required a response on 5 point Lickert scale from strongly disagree to strongly agree.

The instrument was trialed with workers and representatives of a labor union of a large scale SOE in Taiwanese electric industry. Of the total 490 questionnaires mailed or e-mailed, 251 were completed and usable responses returned, yielding a 51.2 per cent response rate. The demographic sample characteristics of respondents are shown in Table I.

TABLE I
Sample Characteristics

Item	Variety	Sample (N)	Sample (%)
Gender	Male	222	88.4
	Female	29	11.6
Age	25 below	2	0.8
	25-34	25	10.0
	35-44	81	32.3
	45-55	110	43.8
	55 above	33	13.1
Level of education	Junior school	4	1.6
	Senior school	30	12.0
	Polytechnic Diploma	105	41.8
	University	93	37.0
	Post graduate above	19	7.6
Level of position	Top manager	1	0.4
	Mid manager	8	3.2
	Grass-roots cadre	90	35.9
	Worker	152	60.6
Years of experience	5 below	5	2.0
	5-15	29	11.6
	15-20	74	29.5
	20 above	143	57.0

Analysis of item responses consisted of factor analysis and the application of the Cronbach's alpha statistic to ascertain factor, reliability and validity. Factor analysis is a statistical technique, which is used to condense many variables into a few underlying constructs [6]. It reduces a large number of attributes by combining them into meaningful groups or factors. Before factors analysis can be used as a data reduction method, it must satisfy the underlying assumption of sampling adequacy [12].

IV. Results

The reliability of the scale was tested using Cronbach's alpha coefficient. Each construct was tested for unidimensionality, reliability and convergent validity using Cronbach's alpha coefficient.

Factor analysis suggested six factors. These have been labeled: Safeguard of workers' rights and interests (factor 1); compensation of potential loss (factor 2); Communication (factor 3); Leadership trust and Employee Consultation (factor 4); Participation of employees and the labor union (factor 5); Encourage the employees to learn and to cultivate a second specialty (factor 6). The Cronbach alpha coefficients for the six factors (see Table II) were between 0.78 and 0.93. The analysis for each factor is presented below.

TABLE II
Cronbach's alpha reliability estimates of six factors

Factors (six constructs)	Eigenvalue	Alpha
Safeguard of workers' rights and interests (factor 1)	16.93	0.93
Compensation of potential loss (factor 2)	2.72	0.89
Communication (factor 3)	2.12	0.85
Leadership trust and Employee Consultation (factor 4)	1.71	0.78
Participation of employees and the labor union (factor 5)	1.46	0.88
Encourage the employees to learn and to cultivate a second specialty (factor 6)	1.28	0.79

V. Discussions and Conclusions

At the outset of this study it was unclear what might be the dominant issues perceived to be affecting workers during the process of privatization of State owned enterprises in Taiwan. Taiwan has a mixed history of Spanish, conquest, Japanese occupation, the Chinese revolution and still ensuing friction with the mainland, a defensive reliance on the United States, and so on. Until recently, Taiwan has been much more prosperous than mainland China and more 'western' oriented. Yet Taiwanese society is still very Chinese. Traditional ceremonies and holidays are still marked. So it was reasonable to establish what factors were perceived important by workers faced with privatization and to understand whether these were effectively the same in research conducted in the west. As it turned out, the factor groupings effectively mirrored the findings from research in the west with the following labels given to the factors identified:

- (1) Safeguard of workers' rights and interests;
- (2) Compensation of potential loss;
- (3) Communication;
- (4) Leadership trust and Employee Consultation;
- (5) Participation of employees and the labor union and

- (6) Encourage the employees to learn and to cultivate a second specialty.

The immediate practical implication of this validation process is to provide general guidance to the Taiwanese government in terms of what it needs to do to hasten its privatization reform process. The findings obviously fall short of being specific as to what actions the government might take. However, the message that better communication is required is obvious and that each the factors identified need attention in practical terms.

The approach taken to data collection was via survey and subsequent factor analysis of responses. The findings are relatively clear cut. However, and without detracting from the findings presented, it is recognized that a different and more qualitative approach may have been used to collect data. Such approaches would have meant that the responses of participants would not have been constrained, or bounded, by the items in front of them on the survey form. These approaches, such as interviews or focus groups, might also have allowed the gathering of data which provided understanding into the value bases of the responses.

There are many factors that might influence support or resistance to privatization of Taiwanese electric industry. Some of these will relate to efficiency arguments with the prevailing pedagogy predominantly being that public enterprises are less efficient than privatized ones. This, of course, is disputable but the tide of opinion is currently against SOEs. It is not known how much this belief has taken root in individual SOE workers and hence the importance of efficiency arguments in relation to resistance to privatization has yet to clarify.

Likewise, it is generally argued that TPC has not met consumers' needs well, with the operational and service performance record of SOEs becoming worse and worse over time. This may be because Taiwan is experiencing a period of rapid and important social and economic change. Accession to the World Trade Organisation, democratic reforms and the general processes of globalisation are bringing about great changes in the domestic economic environment. In Taiwan, the policy goals of the government's privatization efforts have thus been changed to put emphasis on building competition across all industries and promoting the allocate efficiency of social resources. Despite the slow progress of privatization in its first several years, the government has marked privatization as one essential part of the current deregulation drive. There seems little doubt that the government will fulfill its privatization commitment and introduce competition into all markets [3]. The important role of SOEs and former SOEs (after privatization) are closely related to the life and social welfare of the general public. In Taiwan, most basic services are provided by SOEs or former SOEs. The success or failure of the Taiwan economy and society is thus linked with the success of these organisations and it is thus extremely important, among many other factors, to cultivate leadership ability of managers in advance in order to

successfully promote privatization. Development of a deeper understanding of the factors described in this study is a starting point.

Some further research is suggested. In the following papers of this portfolio, the effects on workers in the privatization process in Taiwanese electric industry will be explored. Of interest is the relationship of these variables with workers commitment on six factors, such as gender, age, salary, level of education, level of position and years of experience.

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Using Delone and Mclean'S Model to Evaluate the Electronic Medical Library System of DOH

Tsuey-Yun Weng^a, Jui-Pei Huang^a, Yen-Fang Hsu^b, Andy Hung^c

^a Chi-Shan Hospital, Department of Health, Executive Yuan, Taiwan.

(Correspondence) ^b Public Health Bureau, Chiayi City, Taiwan.

^c Kaohsiung Medical University, Taiwan

Address: 168, University Rd., Min-Hsiung, Chia-Yi, Taiwan, R.O.C. , koymimi@yahoo.com.tw

Abstract: The healthcare (medical) industry is the one that needs highly intensive knowledge and know-how. In other words, health professionals' knowledge is the largest part of intellectual capital within this business. While facing new disease or advanced medical knowledge, doctors and healthcare professionals have to update these new medical information to provide quality care. Considering the working schedule of medical staffs, E-library turns to be the best channel of learning. The Department of Health (DOH) then established an e-library system on the internet to support its hospitals.

In this study, ISS Model The purposes of this study are to survey the users' satisfaction and intention to use of the e-library and to identify the critical factors after exploring factors for users' intention to use and satisfaction. The information system success (ISS) Model modified by DeLone & McLean in 2003 is adopted as research model. of this survey are medical professionals from 25 DOH hospitals exclude their branches and those under outsourcing management. 342 questionnaires are distributed

intention to use, satisfaction level, information quality, system quality and service quality respectively. Finally, the frequency of using the e-library is rather low. It reveals that promotion of the e-library to the DOH staffs is needed. The results of this study serve as a reference for hospitals that intend to adopt e-library for enhancing their medical staffs in updating medical knowledge.

Keywords: ISS MODEL, e-library, healthcare industry .

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and 248 ones are returned which gives a 72.5% of response rate. However, 7 copies among them are ineffective. ANOVA and Structural Equations Model are used to investigate the correlation among variables.

The results show that DeLone & McLean's ISS Model is useful in investigating the usage and satisfaction of DOH e-library system. The subjects all have positive affirmation of using the e-library system. The variables of information quality, system quality, and service quality have direct impacts on the intention to use the e-library. Factors that influence the net benefit of using the e-library system are

The Need for Business Law Co-Ordination in the Global Marketplace

Maree Chetwin

Associate Professor, College of Business and Economics,
Department of Accountancy, Finance and Information Systems,
University of Canterbury, Private Bag 4800, Christchurch 8020, New Zealand
Tel: +64 3 364 2616; Fax: +64 3 364 2727
Email: maree.chetwin@canterbury.ac.nz

Abstract: E-mail is regarded by some companies as a mainstream marketing option. Legislation that prohibits unsolicited electronic messages of a marketing nature is a basis to stop the growth of spam. The ideal solution would be an international framework of legislation and law enforcement, but, legislation around the world has been diverse. New Zealand has taken a wait and see attitude to spam legislation. Its discussion paper "Legislating Against Spam," which was issued in May 2004, made considerable reference to the Australian approach. This paper considers the proposed New Zealand legislation in light of the Australian Spam Act 2003 and the New Zealand and Australian Memorandum of Understanding (MoU) on business law co-ordination. Does the proposed legislation go far enough? Legislation is a positive move. Without legislation, there is no basis from which New Zealand can address spam on a global basis. It is also a move to ensure sound business e-marketing practices which are essential as the Internet increases in importance for business communications. Spam is a global problem and reference is also included to the diverse approaches of the United Kingdom and the United States.

Introduction

E-mail is an important business tool as it is low cost and effective. Increasingly consumers use technology to access information. Related to this has been a significant growth in spam via the internet which threatens the growth of the internet and the information society as a whole.

On July 25, 2005, the New Zealand Commerce Minister, Pete Hodgson, announced that New Zealand and Australia would review their Memorandum of Understanding (MoU) on business law co-ordination. "Better co-ordination has been called for by the business community on both sides of the Tasman and we are interested in their views on the MoU and how it could be improved." Two days later, the Unsolicited Electronic Messages Bill was tabled in the New Zealand Parliament. The Australian Spam Act 2003 was the outcome of the review by the Australian National Office for the Information Economy (NOIE). New Zealand's discussion paper which was issued in May 2004, *Legislating Against Spam*, made considerable reference to the Australian approach.

The Unsolicited Electronic Messages Bill

The explanatory note to the Unsolicited Electronic Messages Bill states that the legislation is part of a multi-tiered strategy to combat the growth of spam along with self-regulation in the form of industry codes of practice, education and awareness campaigns, improved technical measures, and international co-operation. Generally, it is a positive move as it will ensure that New Zealand is no longer a soft target for spammers. However, it should be noted that New Zealand has been slow to introduce legislation and its response is not innovative but rather a weak response to the problem.

Australian Spam Act 2003

The Australian Government website of the Department of Communications, Information Technology and the Arts outlines its "multi-layered strategy to address spam as recommended in the *Final Report of the National Office for the Information Economy (NOIE) review of the spam problem and how it can be countered*. This strategy involves the following elements designed to complement and reinforce each other:

- national legislation (the *Spam Act 2003* and the *Spam (Consequential Amendments) Act 2003*);
- international cooperation;
- information and awareness-raising;
- industry codes of practice; and
- technical solutions.

The Australian Spam Act 2003 and the Spam (Consequential Amendments) Act 2003 were passed by Parliament in December 2003 and both came into effect on 10 April 2004.

Is the Australian Spam Act the best model for New Zealand?

Cheng suggests that "[t]he 2003 [Australian] enactments should be seen as a major step on a long road, rather than arrival at a final destination." This is particularly the case when the Spam Act is considered in light of global developments, legislation in other jurisdictions, such as the United States and the European Directives. It was announced on 2 July 2004 that the Australian Competition & Consumer Commission (ACCC), and the Australian

Communications Authority (ACA) were signatories to a Memorandum of Understanding between the US Federal Trade Commission, the UK Department of Trade & Industry, the UK Information Commissioner and UK Office of Fair Trading for mutual assistance in the enforcement of spam laws. The UK Department of Trade and Industry website outlines the effect -

"It will mean for the first time that:

- Enforcement authorities in the UK, United States and Australia will work together to investigate spammers in those countries;
 - * enforcement authorities across all three countries will take part in joint training initiatives to combat spam;
 - * international solutions and strengthening capabilities will be developed to trace and convict spammers; and
 - * cross border enforcement against spammers will take effect."

United Kingdom

UK spam is covered by a set of regulations. The Directive on Privacy and Electronic Communications (2002/58) was adopted by the European Commission and it was implemented in the United Kingdom via the Privacy and Electronic Communications (EC Directive) Regulations 2003 which came into force on December 11, 2003. The Regulations prohibit the sending of unsolicited emails for direct marketing purposes without the recipient's prior consent (opt-in) unless one of three exemptions applies:

- (a) that person has obtained the contact details of the recipient of that electronic mail in the course of the sale or negotiations for the sale of a product or service to that recipient;
- (b) the direct marketing is in respect of that person's similar products and services only; and
- (c) the recipient has been given a simple means of refusing (free of charge except for the costs of the transmission of the refusal) the use of his contact details for the purposes of such direct marketing, at the time that the details were initially collected, and, where he did not initially refuse the use of the details, at the time of each subsequent communication. (Regulation 22(3))

The sender of all marketing messages must not conceal his or her identity and must provide a valid address for opt-out requests.

The Information Commissioner is responsible for enforcing the regulations, which is one of the major criticisms of the Act outlined by Munir as the Commissioner is "overworked and under-resourced." Munir also criticises the low £5,000 fine for breaking the Regulations and its application. Spam to private email addresses is prohibited but it is permissible to send spam to the employees of businesses. Regulation 22 (electronic mail) applies only to transmissions to individual subscribers (the term "individual" means "a living individual" and includes "an unincorporated body of such individuals"). Motion concludes his summary of the regulations: "A laudable effort

all round on the part of the UK Government, but it is doubtful that any of this is going to make much difference in isolation."

United States

The United States "Controlling the Assault of Non-Solicited Pornography and Marketing Act," otherwise known as the CAN-SPAM Act 2004 took effect as from 1 Jan 2004 and only applies to spam messages which are commercial. Section 2 of the Act outlines twelve Congressional findings and policy, the first of which states: "Electronic mail has become an extremely important and popular means of communication, relied on by millions of Americans on a daily basis for personal and commercial purposes. Its low cost and global reach make it extremely convenient and efficient, and offer unique opportunities for the development and growth of frictionless commerce."

The Act defines "commercial electronic mail message" as "any electronic mail message the primary purpose of which is the commercial advertisement or promotion of a commercial product or service (including content on an Internet website operated for a commercial purpose)." Excluded are "transactional or relationship messages," which facilitate existing commercial exchanges or provide information necessary to existing commercial relationships.

A major criticism of the Act is that it is an opt-out regime. The recipient must be told that he or she will receive messages unless advice is received they do not want them. Commercial messages must contain opt-out provisions and the sender's physical address. Some recipients would take the view that spammers include an opt-out to validate e-mail addresses which could mean more e-mails.

The Act prohibits the use of deceptive subject lines and false headers. In the case of unsolicited email, the marketer must label the email as an advertisement by ADV or other comparable identifier in the subject line. To amount to actionable spam there must be multiple unsolicited commercial emails that do not comply with the provisions of the Act.

The CAN-SPAM Act provides criminal penalties and unlike the UK Regulations the penalties are steep (fines up to 2 million). Zhang notes that some critics consider the possible penalties are disproportionate to the crime.

The CAN-SPAM Act does not allow a private right of action. Parker Baxter asserts that the theory behind allowing an individual private right of action against spammers in small claims court is that a rash of small lawsuits can create significant costs for the spammer that are normally shifted to the recipient of an unsolicited communication and can thereby cause a reduction in the amount of spam sent.

Subsection 12 of the Congressional findings and policy states: "Many States have enacted legislation intended to regulate or reduce unsolicited commercial electronic mail, but these statutes impose different standards and requirements. As a result, they do not appear to have been successful in addressing the problems associated with unsolicited commercial electronic mail, in part because,

since an electronic mail address does not specify a geographic location, it can be extremely difficult for law-abiding businesses to know with which of these disparate statutes they are required to comply." Spam regulation has been removed from state regulation to the federal government and in some cases imposes a softer regime.

Australia

The underlying principle of consent was emphasised on the Second Reading by the Minister for Communications, Information Technology & the Arts -

"The Spam Bill 2003 has as its cornerstone the principle of consent. Has the recipient asked for this communication—which constitutes explicit consent—or is there implicit consent? Implicit consent would exist where there is an existing business or other relationship. Drafting the bill has been a delicate balancing act. We must balance the legitimate needs of business and the concerns of the community."

The Spam Act is divided into 6 Parts – five of which contain a section headed "simplified outline."

Part 1 Introduction s3: Simplified outline

It states: The following is a simplified outline of this Act:

This Act sets up a scheme for regulating commercial e-mail and other types of commercial electronic messages.

- Unsolicited commercial electronic messages must not be sent.
- Commercial electronic messages must include information about the individual or organisation who authorised the sending of the message.
- Commercial electronic messages must contain a functional unsubscribe facility.
- Address-harvesting software must not be supplied, acquired or used.
- An electronic address list produced using address-harvesting software must not be supplied, acquired or used.
- The main remedies for breaches of this Act are civil penalties and injunctions.

The basic definition of spam is in S6. For the purposes of the Act, it is a commercial electronic message. The Australian Communications Authority (ACA, a government regulator of telecommunications and radiocommunications is responsible for enforcing the Act. Its website defines spam as "unsolicited commercial electronic messages regardless of their content". The provisions relating to consent, allow

the sending of legitimate commercial messages. Bulk spamming is covered by penalty provisions rather than in definition.

An electronic message becomes a "commercial electronic message" when it is within one of the listed purposes which include an "offer to supply or sell goods or services, advertise or promote goods and services, or to advertise or promote a supplier or prospective supplier of goods and services."

A commercial electronic message that has an Australian link, is prohibited unless the "relevant electronic account holder" to whom the message was sent consented, or there is a mistake by the sender, or the message is a "designated commercial electronic message."

The Act is much wider in application than either the UK Regulations or the CAN-SPAM Act. It covers all forms of electronic messaging such as mobile text messaging (SMS), multimedia messaging service (MMS) and instant messaging. Fax and voice calls are not covered. The Australian Consumers' Association consider that the Act should cover unsolicited marketing phone calls.

The practical guide for business put out by the Government lists three key steps to provide a clear explanation of the legislation's requirements:

“1 Consent Only send commercial electronic messages with the addressee's consent – either express or inferred consent.”

2 Identity Include clear and accurate information about the person or business that is responsible for sending the commercial electronic message.

3 Unsubscribe Ensure that a functional facility is included in all your commercial electronic messages. Deal with unsubscribe requests promptly.”

There are a number of exceptions for "designated commercial electronic messages" as defined in Sch.1. They must comply with s.17 and include information about the institution or organisation which authorised the sending of the message. Schedule 1, cl.2 and 3 outline the range of messages and list a number of bodies that are authorised such as government agencies, registered political parties, religious organisations, charities and educational institutions. Also excluded from the operation of the Act are purely factual messages but the sender must include accurate contact details of the message's originator (Sch.1, cl.2). Likewise if the relevant electronic account-holder consented to the sending of the message (Sch.2).

"Consent" means express consent; or consent that can reasonably be inferred from the conduct, and the business and other relationships, of the individual or organisation concerned.

The range of penalties is wide and it will depend on the history of the offender and whether or not it is a body corporate or an individual as to the penalty imposed. ACA can issue infringement notices or penalties can be imposed by the courts. Under the former regime, the ACA may choose to issue a formal warning if a person contravenes a

civil penalty provision. Schedule 3 covers infringement notices, the object being to set up a system of infringement notices for contraventions of civil penalty provisions as an alternative to the institution of proceedings in the Federal Court.

Civil penalties are covered in Pt 4. The maximum penalties are substantial and are calculated on an increased scale for repeat offenders. If a business is found to be in breach of the Spam Act a penalty of up to \$220,000 for a single day's contraventions may be imposed. If, subsequently, the business contravenes the same provision, the possible penalty is up to \$1.1 million. For an individual first time offender the maximum is \$44,000 per day and for a repeat offender \$220,000 per day.

Injunctions may be granted in relation to contraventions of civil penalty provisions. The ACA is presently taking action against Clarity1 Pty Ltd of East Perth and its managing director, Mr Wayne Mansfield, and are seeking an interim injunction against the parties to be in force until the hearing because of the scale of the alleged breaches. It is alleged that the parties sent out at least 56 million commercial emails in twelve months after the Spam Act 2003 commenced in April 2004. Clarity1, which also uses the trading names Business Seminars Australia and the Maverick Partnership harvested some of the email addresses to which emails have been sent.

The ACA has been successful against a car company that advertised using text messages. Carsales.com.au was fined \$6600.

The ACA has been active in enforcing the Act by educating Australian businesses and consumers and it has been involved in joint action internationally in combating spam. Not only has it signed the M of U noted above with the USA and the UK to counter spam but it has also signed a joint statement with the Thai government on telecommunications and information technology.

On 1 December 2004, the Acting ACA Chairman, Allan Horsley, in a media release advised the anti-spam initiative with Pacific Internet and the software development company Spammatters. They are conducting a "world first" spam reporting system which enables Pacific Internet customers to report spam they receive via a number of methods including a plug-in to Microsoft Outlook and a web interface.

"When they receive spam, these customers will be able to use the software to forward it directly to the ACA's forensics database system for collection, research, analysis and action," Mr Horsley said. "The database system automatically extracts relevant information from the spam that may help the ACA to track down spammers. This information can be used as evidence in court because the database also saves the spam message with the header and body intact. This enhances its usefulness as legal proof."

"The database system reduces the need for manual spam investigations and is able to process and analyse very large amounts of spam."

Summary of the NZ Unsolicited Electronic Messages Bill compared to the Australian Spam Act 2003.

Clause 3 sets out that the purposes of the Act are to –

- (a) prohibit commercial electronic messages with a New Zealand link from being sent to people who have not given their prior consent to receiving those messages; and
- (b) prohibit promotional electronic messages with a New Zealand link from being sent to a person who has withdrawn consent to receiving those messages; and
- (c) require all commercial and promotional electronic messages to include accurate information about the person who authorised the sending of the message; and
- (d) require all commercial and promotional electronic messages to contain a functional unsubscribe facility; and
- (e) prohibit address-harvesting software and any electronic address list produced using that software from being supplied or acquired for use, or being used, in connection with sending unsolicited commercial electronic messages, or promotional electronic messages, in contravention of the Act.

The proposed Act will apply to marketing and promotional electronic messages whereas the Australian Act covers all commercial messages relating to an offer of goods or services, for example, quotes and invoices.

Clause 6 defines commercial electronic message. It means an electronic message that has, as its primary purpose,-

- (i) marketing or promoting-
 - (A) goods; or
 - (B) services; or
 - (C) land; or
 - (D) an interest in land; or
 - (E) a business or investment opportunity; or
- (ii) assisting or enabling a person to obtain dishonestly a financial advantage or gain from another person; but...the section then lists (i) – (viii) what an electronic message does not include – such as, a quote or estimate for the supply of goods or services. (viii) is a mopping up subsection. It does not include an electronic message that has any other purpose set out in the regulations.

A promotional electronic message means an electronic message-

- (a) that is not a commercial electronic message; and
- (b) that has, as its primary purpose, the promotion of marketing of an organisation, or its aims or ideals.

The Bill follows the Australian approach with regard to bulk spamming. It is not included in the definition but is relevant in terms of penalties.

Both the opt-in and opt-out approaches are utilised. The opt-in approach applies to unsolicited commercial electronic messages that have a New Zealand link. The opt-in approach involves a higher standard. The messages can only be sent if the recipient has consented to receiving them. This can be express or inferred from the conduct and the business and other relationships of the person concerned and any other circumstances that may be specified in regulations. Consent is deemed to have been given when an electronic address has been conspicuously published by a person in a business or official capacity and it is not accompanied by a statement to the effect that the relevant address-holder does not want to receive unsolicited electronic messages. The message sent must be relevant to the business, role, functions or duties of the person in a business or official capacity. Opt-out applies to promotional electronic messages that have a New Zealand link. They are prohibited from being sent to any person who has opted out of receiving messages. It defines how a person opts out of receiving promotional electronic messages. Commercial electronic messages and promotional electronic messages that have a New Zealand link must clearly and accurately identify the person who authorised the sending of the message; and include accurate information about how the recipient of the message can readily contact the person who authorised the message to be sent. The explanatory note to the Bill states that "Regulations made under the Bill, when it is enacted, may specify further conditions about the information that must be included in commercial electronic messages and promotional electronic messages." In addition a functional unsubscribe facility must be included unless the parties agree otherwise. In line with the Australian Act that facility must be reasonably likely to be functional and valid for at least 30 days after the message is sent.

Covered are all messages generated within New Zealand and all messages sent to a New Zealand email address. This is also in line with the Spam Act as are the provisions relating to prohibiting the supply, acquisition, and the use of address- harvesting software and harvested-address lists in connection with the unlawful sending of messages.

Again only civil remedies apply but for New Zealand the maximum is \$200,000 for individuals and \$500,000 for bodies corporate.

The Bill provides two defences. They are applicable where the person sent the message by a reasonable mistake of fact or the message was sent without the person's knowledge.

Consumers and users are required to resolve any spam problems with the sender and their Service Provider who in turn is required to refer matters to the government enforcement agency. Individuals cannot complain directly as according to the explanatory note to the Bill this places higher cost on Government and does not resolve issues by ISPs who are best placed to take technical measures in relation to spam originating from overseas. This could be unduly onerous for the ISP provides and it restricts the individual's remedies. The Department of Internal Affairs

is responsible for enforcing the new legislation, educating consumers, users and businesses and promoting compliance.

Has New Zealand emulated the Australian Spam Act?

The proposed New Zealand legislation is very similar to the Australian Spam Act. Is it better? The title differs as does the ordering of many sections. Likewise different words are used although essentially their purpose is the same, for example the Australian infringements are called contraventions. It is difficult to understand the reasoning behind some of the changes, particularly in view of the MoU and the frequent aspirations of a single economic market. A parallel development occurred with the New Zealand Commerce Act which was introduced after the Australian legislation but it is very similar. Some sections were reworded and the rewordings have proved to be detrimental. It is apparent that a lot of the changes in the Unsolicited Electronic Messages Bill are cosmetic only and seem to be of little benefit in the fight against spam.

The New Zealand Bill does include standard search and seizure provisions. Similar provisions were included in the Australian Telecommunications Act via the Spam (Consequential Amendments) Act 2003.

The New Zealand Government has had the benefit of a number of legislative models and their critics but has not taken advantage of the opportunity to make legislative innovations in the spam area.

Chetwin and Clarke suggest that a unique role for the law lies in requiring the deployment of technical defences against spam and in imposing heavy penalties not only for non-technical misdemeanours (such as buying and selling address lists) but also for operating email systems that lack these required technical defences. An example suggested is legislating that all mail-systems must implement technical barriers of a certain efficacy against spoofing.

Ryan Hamlin, the head of Microsoft's Technology Care and Safety Group has criticized the Bill as being "too broad" and feared for the future of email marketing. He advocates the American opt-out approach which New Zealand rejected as being too weak. In Hamlin's view, the Bill as it is could prevent businesses from sending out emails to people who had been customers. Labelling of advertising emails, for example by ADV in the subject line, would have the advantage that recipients could filter out the unwanted messages.

Conclusion

The Congressional Findings and policy in the CAN-SPAM Act summarised the problem with legislation which has been echoed in all other jurisdictions:

"(12) The problems associated with the rapid growth and abuse of unsolicited commercial electronic mail cannot be solved by Federal legislation alone. The development and adoption of technological approaches and the pursuit of

cooperative efforts with other countries will be necessary as well."

Regardless of the jurisdiction discussed there are critics of the legislation in force or the proposed legislation. There is no easy answer. The Memorandum of Understanding on 2 July 2004 between the US Federal Trade Commission, the UK Department of Trade & Industry, the UK Information Commissioner and UK Office of Fair Trading and the Australian Competition & Consumer Commission (ACCC), the Australian Communications Authority (ACA) for mutual assistance in the enforcement of spam laws is a major step in the right direction. The ACA Acting Chairman acknowledged that on its own it will not solve the problem but it is an important start.

It is essential that New Zealand move quickly to pass legislation so that it can participate in any future international agreements and that spammers do not see it as a safe haven for transmitting spam. New Zealand has utilised the Australian Act as a model. The question remains why the minor unimportant changes which seem to be of little benefit? An international framework of legislation and law enforcement is required.

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A SCADA System Application in Load Management

Ming-Yuan Cho Jung-chin Chen
Electrical Engineering Department
National Kaohsiung University of Applied Sciences, Taiwan
a092304104@cc.kuas.edu.tw

Abstract: 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, operating monitors, the analysis on load characteristics and to drop the cost of management.

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 telecom stations and to provide decision-makers and managers with useful operation and management strategies as reference.

I. Introduction

In Taiwan, 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 Taiwan Power Company (TPC) emphasize 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 purpose of this research is to apply SCADA system and a feasible load management options for the telecom industry to reduce the power cost from the view point of demand side management.

Now SCADA system applies in telecom stations and mobile stations in Taiwan, the characteristics of management and operation can be proposed such as monitor, control, load management and analysis [4].

II. A SCADA Management Framework Application in Telecom Industry

II. 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 [5]. 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 [6].

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 [5]. Focus, which selects one or more segments of the company's advantage and tries to develop competitive advantages, such as A SCADA system.

A SCADA system management framework include: Terminal Processor (TP), Monitor and Controller (MAC), Sensors and Transducer, shown as figure 2.1.

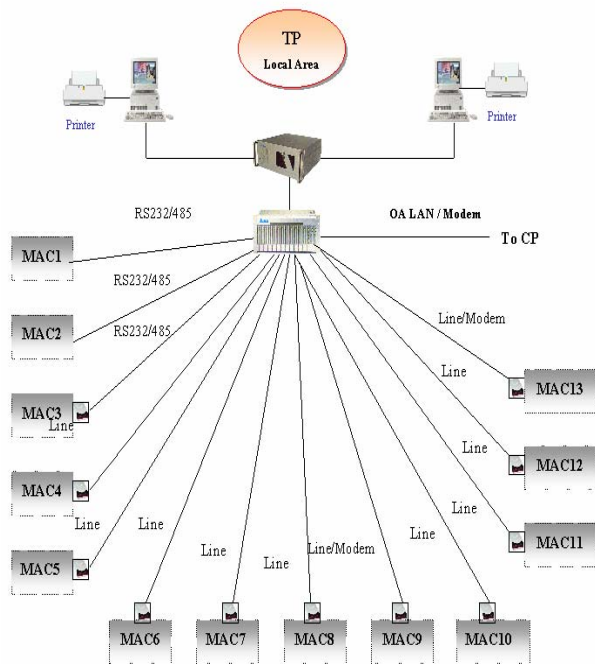


Figure 2.1 The TP Management Framework in SCADA System

II. 2 The Equipment of Monitor and Control in Telecom Station

Monitor And Controller (MAC) provides the interface of monitor and control in telecom station (see figure 2.2) [13] [14].

Alarm items include as follows:

- AC source -- AC current / AC voltage detect
- DC equipment -- DC equipment alarm / DC voltage output
- Air condition -- Air condition operating status and Temperature
- Control Entrance -- Control Entrance detect / Alarm detect

Control item include as follows:

- Air condition control -- Air condition operation / Fan / ON-OFF.
- DC equipment -- DC equipment alarm / DC voltage output.
- Load control and management
- Data collection and analysis

Data collection from SCADA system, the power consumption ratio of each process and power consumption of major equipment in the telecom industry can be analyzed to cope with load management procedure.

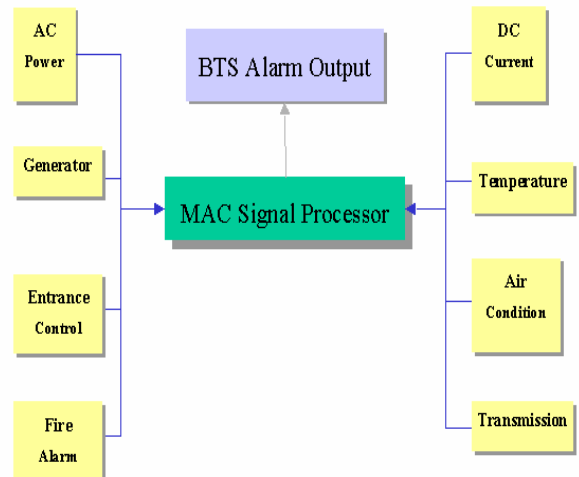


Figure 2.2 The MAC on Monitor and control equipment in SCADA System

III. The Load Characteristics and Rate Analysis

III. 1 Foreword

This chapter will study and analyze the rate policy of Taiwan Power Company. Afterwards the power consumption status of telecom station is observed through SCADA system gathering daily load curve characteristics. In the meantime the electricity rate of customer is served to evaluate its potentiality in the load management participation. This chapter will also discuss the customer's various load factors in order to sum up the power consumption characteristics of the telecom industry.

III. 2 The Load Characteristics Analysis

Generally the implementation of load management centers on price strategy. Assisted with the control of customer load and techniques in changing the power consumption ratio between on-peak and off-peak hours, the goal of price strategy can be achieved by applying various communication and control equipment. Yet the comprehensive and general rates in the price strategy such as demand charge, Time of use (TOU) rate are more complicated. Besides it can be applied to many customers and shall not be changed regularly and greatly. The power industries in the advanced countries adopt localization and selection policy. The target is set on those customers with large power consumption and high power cost. Along with price incentive, the results in the flexible use of power system & resource as well as load management can be attained. This is similar to the rate policy adopted by Taiwan Power Company.

The analysis on power consumption characteristics

Figure 3.1 depicts that the monthly power consumption of sampling customer. It indicates that on-peak power consumption is higher than off-peak power consumption.

For instance, on-peak power consumption in July is more than off-peak power consumption by 300,000 kilowatt-hour. The analysis of power consumption characteristics of sampling customer is as follows:

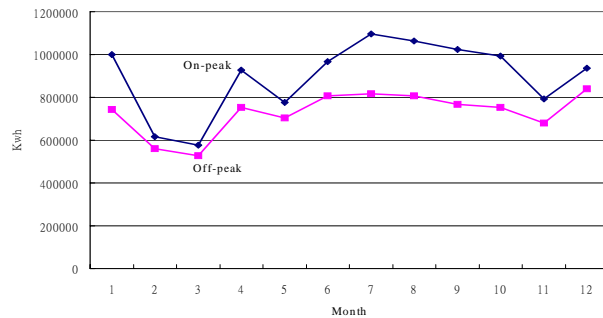


Figure 3.1 The Monthly Power Consumption Kilowatt-hour of On-peak and Off-peak Hours

The daily load curve of sampling customer is shown as figure 3.2, which indicates the power consumption in on-peak and off-peak hours is more than that in off-peak time. In this figure, the load factor in the scope of work day is within 70% ~ 85%, while that of non-work day is 80%.

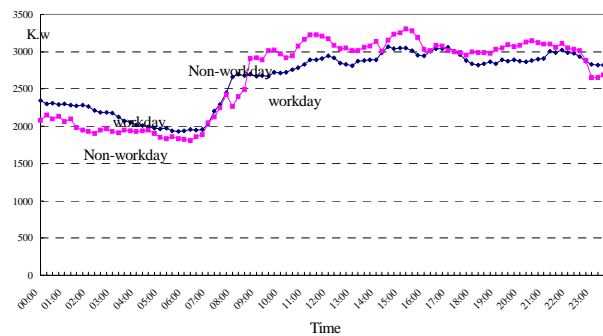


Figure 3.2 The Daily Load Curve

Figure 3.3 is the weekly demand factor of sampling customer. In this figure, the demand factor of work day is small and within 52% ~ 60%, while that of non-work day is about 57%.

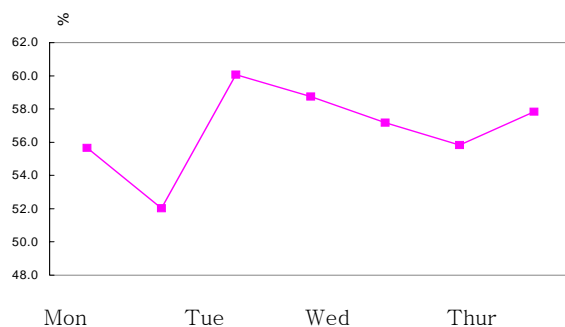


Figure 3.3 The weekly demand factor of customer

In figure 3.4, the demand factor of work day is small and within 52% ~ 60%, while that of non-work day is about 57%.

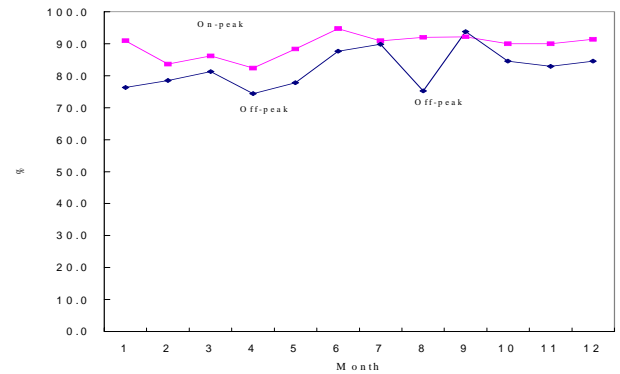


Figure 3.4 The Monthly Demand Factors in On-peak and Off-peak

IV. The Analysis of Load Management

IV.1 The Analysis of Interruptible Load

Taiwan Power Company is proactively engaged in the power development and implements the various load management measures such as the interruptible rate, TOU rate and seasonal rate in continuous effort with the hope that the reliability of system power supply and clipped peak load can be increased. Taking the interruptible rate for example, Taiwan Power Company started the implementation since 1987 and expanded as well as revised its contents year by year. Based on the power system, the six different scope of the interruptible rate is planned for different industrial customer's selection. Besides according to its interruptible capacity, Taiwan Power Company has its demand charge discount, if the customer inks the contract with Taiwan Power Company.

IV.2 The Load Demand Control Analysis

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 [7] [8].

The rate, which Taiwan Power Company charges to the industrial customer, is the total power consumption in each months, 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.

IV. 3 The Analysis of the Optimal Demand Contract

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 become 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.

V. Discussions and Conclusion

V. 1 Discussions

The Analysis of Implementation of TOU Rate (Strategy One)

During the plant visit, the customers expressed their interests in the daily load curve figure of the power consumption. In line with the power consumption and rate analytical figure of on-peak & off-peak hours provided by this research, the customer realizes that the TOU rate measures will save its electricity cost in very short time. Thus the customer participates in the load management options. Meanwhile, the telecom industry will consider how to change process to cope with various beneficial rate options provided by Taiwan Power Company.

Due to the characteristics of process and equipment running, the telecom industry can further implement the TOU rate options.

The Analysis of the willingness of participating the Interruptible Rate (Strategy Two)

The customer usually operates in the full load production. Yet under the recession impact, the actual peak load has already decreased to 75% of the original demand contract or it has been lower than that. It can be realized by introducing between the peak load and the demand contract of daily load curve. It is therefore suggested that the customer should review its actual load capacity to well coordinate with power consumption. The reduction of demand contract or participating the interruptible rate package can be the alternatives to drop down demand charge. Besides the customer can arrange the equipment of the original production equipment under the condition non-full loaded. Meantime the production procedure and time can be re-planned and arranged to avoid the concurrent operation of heavy load equipment which will result in the very high load demand can not be reduced.

Since the customer worries about damaging the semi-product; They will transfer the process to the night and thus increase the difficulties on management.

The Analysis on the Load Demand Control (Strategy Three)

The customer expressed willingness in the load demand control, but the installation of automatic load 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.

The Implementation of Optimal Demand Contract (Strategy Four)

In the plant visit, the optimal contract capacity is not well implemented for customer. As the customer roughly estimates the optimal demand contract based on the historical information and doesn't rigidly analysis by the mathematical method. Thus the expenditure of demand changed increase. After explanation and analysis, the customer willingly proceeds the implementation of optimal contract capacity.

V. 2 Suggestions

1. It is suggested that the telecom industry should review the ratio between current capacity and demand contract in order to decrease the demand contract or participate in the interruptible rate package for the reduction of demand charge.
2. It is recommended that the customer should adopt the load demand control to automatically adjust load as long as the load consumption varies so that the peak load won't exceed the demand contract.
3. 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.

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The Segmentation Talisman - 'Consumption Pattern Strata'

Dhrupad Mathur

Lecturer, Center for Information Technology,
S P Jain Institute of Management & Research, Mumbai
dhrupad@spjmr.ernet.in

Abstract: Since the very inception of marketing discipline, there has been a quest to address the customer meaningfully. From the seller's market conditions to the buyer's market condition, this quest has become all the more prominent now, to the extent that the products and services are supposed to be intrinsically customer focused. Companies are fighting over the tough-to-get market shares.

All this has translated into another endeavor of catching the customers through different dimensions of the possible market implements. Information and Communication Technology has been very radical in transforming the traditional functional processes. Same applies here as well. This paper elaborates, how to develop customer segmentations with the help of IT tools. Therefore, shunning the traditional symptomatic attributes.

I. You Are What You Do

"It doesn't matter where you come from, who you are; what matters is what you do". This is the avowal that is going to change the paradigm of customers' segmentation in time to come. Traditionally, we all have been following the pattern of segmentation variables, which includes demographic, geographic, psychographic & behavioral. Or popularly the customer based, product based and competition based segmentation. However, in pragmatic sense what is more important is to understand the consumption pattern and preferences, because this clearly reflects the potential of a person to get into a segment more meaningfully (*we have the evidence of previous consumption*). To illustrate the concept- Hypothetically, from an international tour operator's customer profile, it is found out that 45% customers are middle aged graduate males residing in north Indian cities with population more than 10 lakhs. This is "what they are". Conversely, if we deduce a relation ship, which indicates that 45% of their customers already had a mobile phone, credit card and a four-wheeler. Therefore, there exists a stratum with a particular characteristic, which signifies that they seek a certain set of values. This is "what they do"

II. Old Is Not Always Gold

The value-based view of any business transaction should be considered. Segmentation is the process of identifying the value, while targeting is communicating the values and

values are delivered through positioning. The very concept of Segmentation is about identifying the values. The existing classification defines values sought in a vague manner. Consumption pattern is more relevant and is of epitome importance as it reflects the values sought and searched by the customer.

Astonishingly enough, the various traditional segmentation variables will automatically be taken care of in a more meaningful manner, chiseling of the unwanted when this stratum is carved out. For example, for person who is a user of both a cell phone and credit cards, there is a greater likelihood that he is at least aware about the various four wheelers available in the market, this chisels away and also gives proper shape to the important traditional segmentation variables like: behavioral – readiness stage, Demographic – age, Psychographic – social class etc.

Adapting the stratum approach will make the application of traditional variable redundant. As, out of the set intersection of traditional variables we search for the segments to be addressed, this refining will reflexively be done when we pick up a stratum dealing with similar set of product value. Therefore making it more comprehensive, addressable, meaningful and pinpointed.

Marketer endeavor to search for the customer preferences by various direct and indirect approaches, while the stratum identification itself speaks of the same. We can have reasons to assume that a high-school teenager, whose family income more than Rs. 1,000,000 p.a. is likely to go to a premium dress material showroom. But can be almost sure that this teenager will be a prospect for this dress material showroom if he is already having a premium segment car, goes to discotheque and is regular Hollywood movie watcher. "Consumption pattern" is the word.

III. Determination of Consumption Pattern and Identification of Strata

Correct identification of Reference groups & strata can be done using data mining and business intelligence. Therefore the businesses of tomorrow will be extending their arms to the customers predominantly relying on the technologies that are able to render very reliable and accurate information in diverse forms and this information shall have varied applications. The Integrated marketing communication will change and he direct marketing efforts will be better addressed.

This approach can effectively supplement the traditional segmentation variables, where the new markets are to be developed and not enough data regarding the existing pattern

is available. This will enable the marketers to address the various segments in a more meaningful and better way, empowering them to evolve the Unique Marketing Proposition rather than only Unique Selling Proposition. It has potential to stand through the dynamics of the business environment daunted by radical technological product innovations and business model obsolescence.

There would be a complete shift of focus from Product based view to the Customer based view of the marketing arm of the business. Not that how they are related to the firm but how they are related to others. Owing to the precision of data mining and exactitude of extraction of information, this stratum approach has tremendous potential to reduce IMC overheads and increase response rate. With ICT proliferation and e-Business adoption, soon its will become norm rather than exception.

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The author has done his PhD in e-Business area and is a Sun certified programmer for Java2 platform. He can be contacted at: dhruPAD@spjimr.ernet.in

Dealing with Post-Kogeko

Hans M. Moonen, Arthur C. Oink *, Jos van Hillegersberg **

* RSM Erasmus University,

Department of Decision and Information Sciences

Burg. Oudlaan 50, P.O. Box 1738,

3000 DR, Rotterdam, The Netherlands

{hmoonen, aoink,}@rsm.nl

** University of Twente,

Department of Information Systems & Change Management

P.O. Box 217

7500 AE, Enschede, The Netherlands

j.vanhillegersberg@utwente.nl

Abstract: Inter-organizational systems are only used to some extent within the domain of transportation and logistics. Distributed agent technologies show a large potential to build a new generation of inter-organizational systems that overcome the hurdles earlier technologies were not able to take [2, 4]. In this paper we present an ongoing research project in which we try to establish a WebServices based agent platform to be used by a logistics service provider (LSP) in an inter-organizational context – which will connect the LSP's internal processes, with processes that span organizational boundaries and therefore is likely to result in interesting process improvements; cost savings and improved competitive advantage are expected outcomes. This paper describes the process we followed, and gives a glimpse of our preliminary findings. We conclude the paper with a short discussion and our research agenda.

I. Introduction

Despite their 'spider in the web' character, the domain of transportation and logistics does still only show a limited application of inter-organizational systems [2]. Although sophisticated systems have been arrived and adopted for routeplanning, warehouse optimization and plant control, a widespread adoption of inter-organizational (planning) systems (IOS) is still lacking. Only some of the larger companies actively utilize EDI or XML technologies for integration with business partners, but most companies still use the phone and fax as their primary means for their inter-organizational coordination activities. Most of the solutions that do work, work in a point-to-point context: a direct integration between two companies. Centralized hubs or exchanges show only limited adoption [1].

We hypothesize that in order to get industry wide adoption of IOS several factors need to be satisfied: there is a need to utilize open non-proprietary standards, a need for (cheap) quick connect capabilities, and the system's architecture should be of a decentralized control type: not giving away ones own business processes, only a basic exchange of data [6, 7, 9].

The Distributed Engine for Advanced Logistics (DEAL) project is a large Dutch government funded long-term research project focused on the creation of an agent based inter-organizational information system for road logistics. Seven partners participate within DEAL [10, 11]. Within the context of DEAL, a wide array of research takes place: ranging from work on performance indicators, to very technical agent technology research, and from mathematical optimization to work on LSP strategies.

This work-in-progress paper is the result of design research performed by the RSM Erasmus University at LSP Post-Kogeko, both partners within DEAL. We describe the approach we followed: from workflow visits to the planning and IT departments, to our redesign, and workshop-sessions that led us to new steps that improved our designs. Finally we give a first impression of the new designs we are developing and are about to prototype within the next months – i.e. we detail a customer linkage we are developing together with Post-Kogeko's customer CoolControl.

II. Post-Kogeko

Post-Kogeko is a Maasland, The Netherlands, based Logistical Service Provider (LSP), active in distribution, forwarding and transport. This includes, among others the transport of: fresh goods, fruits and vegetables, bread, and sea-containers. Post-Kogeko employs currently around 300 employees, and is constantly seeking for growth opportunities and process improvements. It partners in DEAL, which it perceives as an important development to establish an information processing environment that might help them in better serving its customers needs.

Within the context of DEAL we started a process analysis project with Post-Kogeko, focused on their container transport unit. The choice to focus on the container unit was made together with Post-Kogeko management – its main reasons were the relatively low automation of this unit, its inter-organizational setting with many external stakeholders, and Post-Kogeko's plans for further growth in this area.

The physical flow in the Post-Kogeko container business is almost always as following: a loaded container has to be picked up at a container terminal in the Port of Rotterdam,

transported to a customer's site, where it will be unloaded by the customer, after which the empty container is transported back again to the same or a different container terminal in the Port – this process is depicted in Figure 1. The (container) planning department takes care of all the work that needs to happen before actual execution can start: it receives the customer orders, handles the paper work with the customs and the terminal, checks whether containers are already available for transportation, and assigns specific

trucks to specific orders.

In principal a relatively straightforward and simple planning process, but complicated by the fact that from the containers that have to be transported during a certain day, only half of these is actually available at 6 O'clock in the morning when operations start. The rest will only leave the sea going vessel somewhere within the next twelve hours. As a result, planning truly has an event based character.

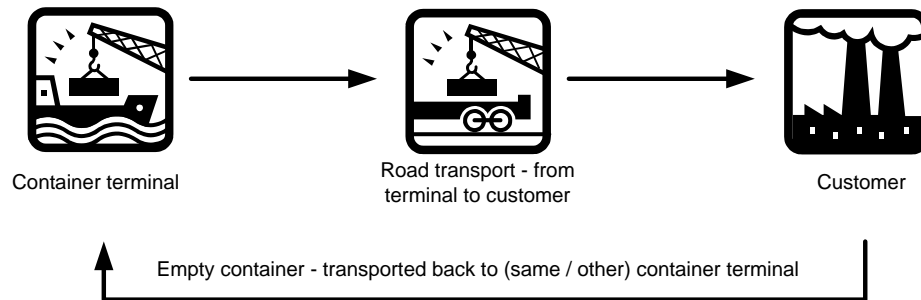


Figure 1 – Basic physical flow of containers in the Post-Kogeko container business

III. The Research Design

The research methodology we followed is a combination of design science as is a usual approach within the computer sciences [5], and action research [3] coming from the social sciences. The objective of our work was to first investigate whether there are actual possibilities and needs for an agent-based inter-organizational planning system within the Post-Kogeko container unit, and if so to move ahead and start designing and implementing such a system.

Two days on the planning floor were our starting point. We were sitting together with the planners, followed and observed their way of working. Meanwhile there was plenty of time to not only observe the way they worked, and the things they did, but also to ask for explanations and all kind of process details.

An in-depth session with the IT administrator responsible for the systems was our next step. He showed us the systems, the integrations, and gave us a login to CarrierWeb (one of the systems) and an Excel data dump of the planning system Qfreight.

Following this, we analyzed the data from the planning system, to further understand the environment, i.e. with respect to inter-organizational dependencies and linkages with respect to both customers and container terminals.

In parallel with the previous steps we worked on process descriptions of the container planning process – UML models, as well as textual descriptions. Our analysis of the business process revealed many small inter-dependent sub-processes, and therefore we choose to model the process in small sub-processes and not as one large integrated process. Having all those inter-dependent sub-processes, we started rethinking each and all of them which lead to some redesign suggestions – sometimes as simple as just automating the

process, sometimes creative solutions were we added new functionality.

IV. Data Analysis

The two days on floor, in-depth sessions at the planning department resulted in a series of UML-diagrams. We choose to model the process in smaller sub-processes, since that was what we observed in practice – furthermore this gives the advantage that it is easier to focus on specific parts. We will discuss the sub processes in order of appearance.

The first sub-process is the order-intake. See Figure 2, which shows the activity diagram for the order-intake. Here the customer sends an order to Post-Kogeko. If Post-Kogeko accepts the order (which they usually do), the order is entered in Qfreight – one of the two IT-systems Post-Kogeko uses. Customers usually sent their orders using fax (occurs the most), e-mail or telephone. In this phase errors can occur, due to manual re-entry of data, e.g. a planner can enter an order twice (which happened). This process can easily be automated using a database webfront or WebService where customers can enter orders themselves. All what than would be left for the planner is to validate the order and accept it.

The remaining part of the process can roughly be divided into two separate sub-processes. The first sub-process concerns the planning of the first orders to be executed the coming day. This is done at the end of the previous day because of late-arriving orders. The second sub-process concerns the rest of the orders. This is performed in real-time during the day.

The first sub-process contains two steps. First, the planner marks all the orders that need to be executed first, see Figure 3. Customers define time windows for their orders, so this is fairly easy done. In the second step, the planner assigns a truck driver to each order he just marked.

Here the planner takes in mind personal preferences and other parameters of concern. See Figure 4. If there are not enough drivers available the planner asks the other department if they have drivers available. If they don't, they hire charters (which are external carriers/drivers that temporarily are employed for Post-Kogeko).

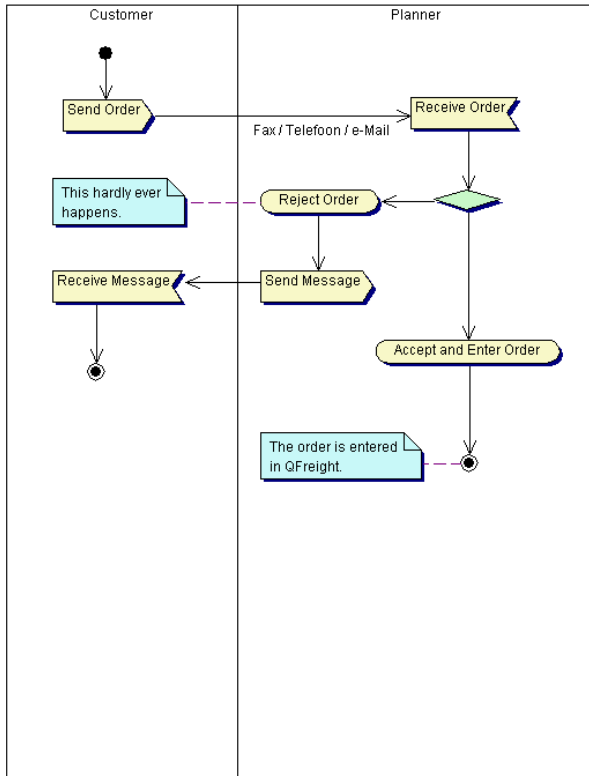


Figure 2 – Order-intake

This process can be automated using a decision-support system. The system could automatically build a list of orders to be executed first. It could also calculate how many truck-hours are needed and conclude that it would save a driver if for example an order is executed later. If you take this one step further, the system could also negotiate with the customer about the time-window the order had to be executed.

The second sub-process is the more complicated one. Here a planner assigns a new order to a driver when the driver is finished with a previous order, see Figure 5. On the one hand the planner continuously monitors the status of a driver (using CarrierWeb). On the other hand the planner monitors the status of a container and checks to see if the custom-papers are ready. Planners can check the status of a container on some of the websites of the terminals where the containers arrive. When both drivers are available and the container is unloaded from the ship, the driver can execute the order. This last part is complicated in a sense that the planner has to anticipate on the arrival of the containers. He already send the driver in the direction of the next order he/she is about to execute. This is also the part of the process where a lot of delays emerge, e.g. a driver is sent to a

terminal and when he/she arrives the container is still on the ship because it is delayed.

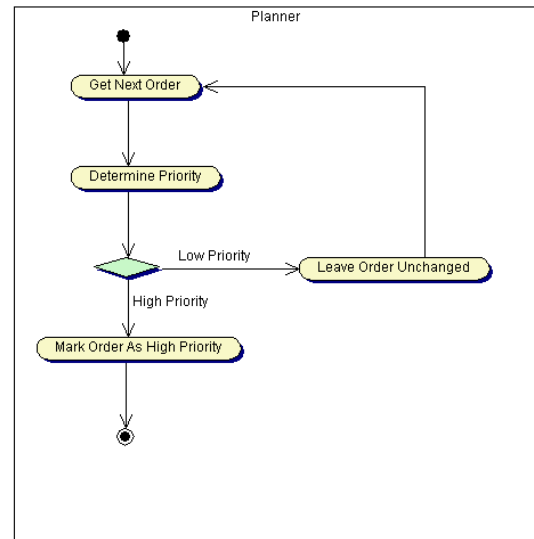


Figure 3 – Set priority orders

This process should be automated using a multi agent planning system (MAS). Within the DEAL-consortium, various parties are busy designing MAS' to overcome the planning problem.

The last part of the process is the order execution. The terminal loads the container and the driver drives to the destination-address. Here the customer unloads the container and afterwards the driver returns the empty container to the return-address (often the same terminal as the pick-up). Once empty the driver gets the next order assigned.

Another part of our process-analysis concerned about an analysis of a dataset of Post-Kogeko's orderhistory. Therefore we received all the orders executed in the first three weeks of 2005 – which accounts up to 1216 orders. Here we noticed some very interesting facts. For example, a small group of customers is responsible for the largest part of all orders. As can be seen in Figure 6, the nine biggest customers (1/3 of the total customer-base) equal 84% of all orders. One note has to be made, this data also contains 408 so called OffHire-orders, which are a special kind of order. If we leave these orders out of the dataset, CoolControl is the biggest customer. We estimate that if Post-Kogeko automates the order-intake process, it will roughly save them about half a day of work for one of its planners. This is the basis to make a prototype of an inter-organizational coupling to the customers.

Another interesting fact we noticed is that the four biggest terminals are responsible for 77% of the orders. See Figure 7. Planners now have to manually check a website of a terminal if they want to know the status of a container. We estimated that if we could realize an inter-organizational coupling to the four biggest terminals it will save Post-Kogeko about an hour a day.

V. Prototype Building

In a focused process workshop with the Post-Kogeko planners and management we went through our process analysis and redesign suggestions. The session was an interesting learning experience for both sides. A concrete choice was made to focus our efforts for the next period on three concrete sub-projects: namely the designing of an event-based internal planning engine, an inter-organizational coupling to the terminals, as well as one to the customers. Pragmatically, we decided to start with the latter, since the first will be worked on in parallel in a larger research effort within the DEAL consortium, and access to customers was easier to arrange than access to container terminals.

Together with Coolcontrol, which is one of Post-Kogeko's top customers, we sat together discussing their process and linkages with Post-Kogeko. We gained insight in their processes, and the way they communicate with Post-Kogeko. Coolcontrol, still largely working with the fax and phone, reacted very enthusiastic to our plans, and committed to work along with us in a redesign and prototyping effort to work on an electronic integration between them and Post-Kogeko.

After having ensured interest from Post-Kogeko in our redesign as well as from one of its customers we can start our design work. Concretely, we plan to utilize a WebServices based process orchestration environment [e.g. Oracle BPEL Process Manager – which is freely available for research purposes], to build a process oriented agent system [8, 9, 12, 13]. A BPEL process, or other specific WebService, can be seen as a light-weight agent, which is possible to trigger and interact with other services/agents. The advantages of such a platform above specific agent toolkits are the ease of integrating with existing systems, the proven technologies and use of open standards.

As we outlined in our research description, the next step was to have a detailed process workshop together with Post-Kogeko planners and management. In this session we validated our models and spoke about some suggestions for improvements and ideas how to build automated support functionality for these processes. In good conversation we decided to focus our design efforts on the design for an internal planning engine (which relates to the sub processes of planning the first and second order), an inter-organizational coupling to the terminals, as well as one to the customers – automating order intake, and giving a customer more visibility in Post-Kogeko's processes.

As the previous paragraph showed, a process redesign with inter-organizational couplings could be very profitable for Post-Kogeko. It not only makes the process more efficient, it also adds additional functionality. We choose to go for an agent-oriented design, and plan to utilize BPEL (Business Process Execution Language) – which is a WebServices based standard for the design and deployment of process driven WebServices. Those WebServices can invoke other WebServices, either inbound within the own organization, or externally to another organization's

information system. Using Oracle BPEL Process Manager we are able to build a service oriented architecture for Post-Kogeko. We utilize the open source application server JBoss as our application server platform, therewith making it of little risk for Post-Kogeko to start using it [since it does not need to invest in expensive server software before experimenting with our pilot system]. As a starting point we decided to look at the order intake process and set up the specifications together with the largest customer CoolControl – a firm active in the import and trade of tropical fruits.

CoolControl is very interested in automated order intake functionality for Post-Kogeko – a process that now still looks like fax-forwarding. Besides the ease of entering orders directly they also let us know that they are interested in a limited track&trace-functionality, e.g. they would like to know half an hour in advance when a container arrives at the destination-address. Concretely they stated: *“currently we call upto 20 times a day, to figure out where our containers are... we would be very much helped with such functionality automated on a website”*. Another functionality they are interested in, is a history of the orders they entered in the Post-Kogeko system. This way, they don't have to store it themselves – something they currently only do to a limited extend.

The next step is to built services that can be accessed via an external WebService or simply manually through a simple web-interface where the customer can log in and place orders, watch its order history, and view the status of orders in execution [container waiting to be picked up, container in transport, etc.].

The next inter-organizational coupling we plan to look at is a coupling with the container terminals. Together with them we plan to build a WebService which accepts container-numbers as parameter and returns the status of the containers – saving large amounts of time of planners manually tracking whether containers are available already. Additionally, a software agent can query the web services as long as a certain requirement isn't met, e.g. container not unloaded – this way avoiding process inefficiencies where containers are available already at the terminal, but not yet tracked/discovered by the LSP to be picked up. Additional inter-organizational couplings that are closely related to this terminal coupling is a coupling with the customs, to track whether paper-work is arranged already, and the container is declared to freely enter for hinterland transport.

Beside these inter-organizational couplings, which basically deal with information exchange, we also consider the actual planning itself. Currently various researchers working within the DEAL-consortium are designing MAS-planning systems. The agents from the planning system will use various WebServices for their requirements. Few are already implemented, and therefore we plan to build some prototype BPEL WebServices in order to get a fully functional system. The MAS systems designed by the different DEAL-researchers than could be relatively easily plugged in and evaluated within the Post-Kogeko context.

VI. Lessons Learned

The transportation industry is an industry with still surprisingly limited automation [10, 11]. And although some parties do use automated systems for their own planning purposes, most inter-organizational communication is still largely a manual process with many data re-entry steps.

Interesting enough, we notice a large availability of sophisticated technologies in the chain; like for example the CarrierWeb system that Post-Kogeko utilizes and that provides every minute an update on the location of all its trucks, the driving speed, the temperature of the cargo its transporting (if needed), and so on. What we however see is that all this information is largely led to human interpretation, and no (automated) intelligent services are build on top of these. It would for example be relatively easy to calculate knowing the location and speed of a particular truck when this truck is likely to reach its destination (i.e. when taking traffic jams into account, a service that can be obtained from elsewhere).

In this research we follow a very pragmatic approach, where we work along with the company stakeholders, observe their processes, and use these as a starting point for our redesigns. Reasoning from these we start small, with very obvious WebServices, but with some of the immediate needs. Perhaps not directly the most interesting parts that provide an intellectual challenge, but elements that are definitely needed in establishing a company wide information architecture, that is relatively easy to couple and link with other organizations – thus enabling a process driven inter-organizational system.

In this paper we show part of our data analysis and process redesign, our ideas for the prototype, and show some preliminary conclusions. Open research questions for the remainder of this research are, among others:

- Can we utilize WebServices environments to establish agent-based inter-organizational systems?

- How useful are such platforms in SME's?

Is this design approach, as described above, a good way to establish such systems in practice?

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Find below a list of used references. This list is not extensive. For a future version of this paper we might extend it – as we add a more thorough literature review to our paper.

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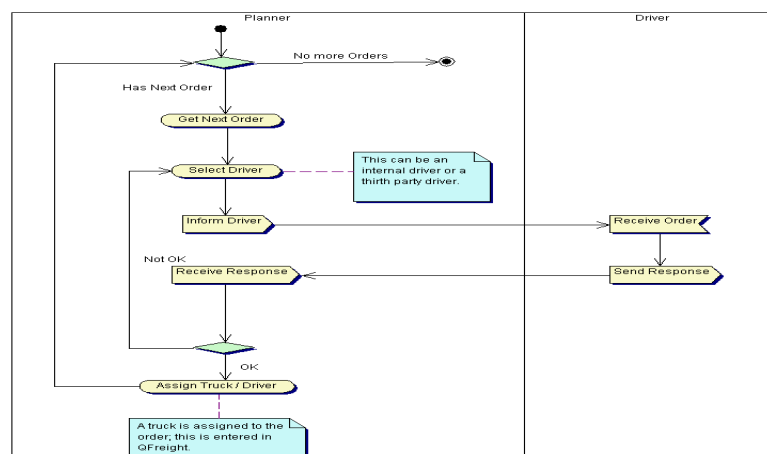


Figure 4 – Assign drivers to orders

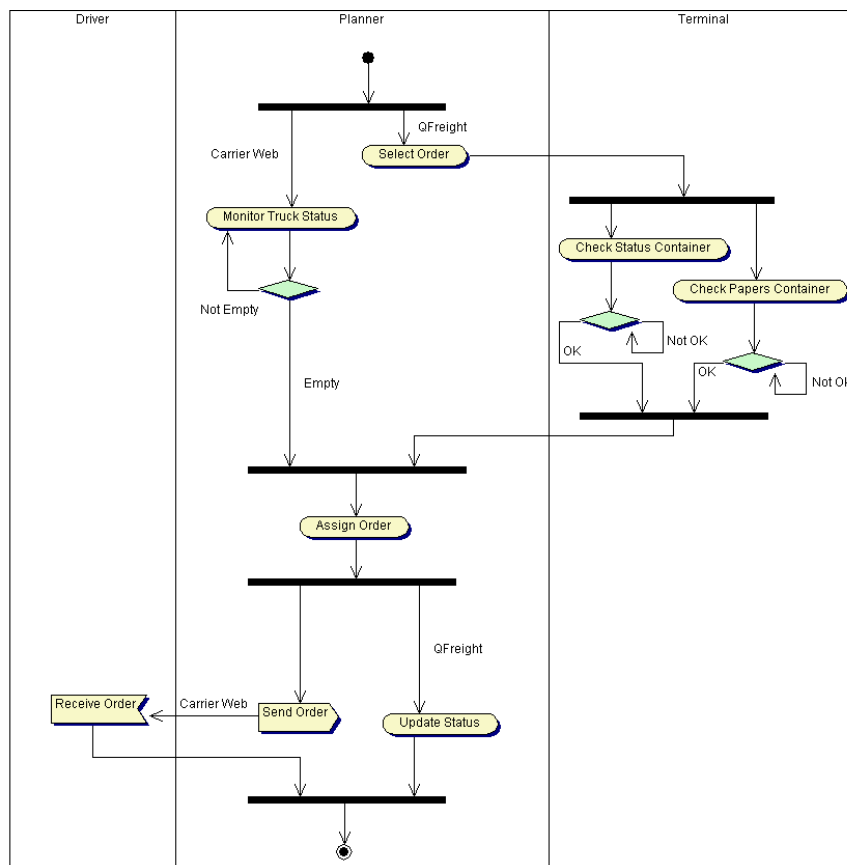


Figure 5 – Assign second (or later) order

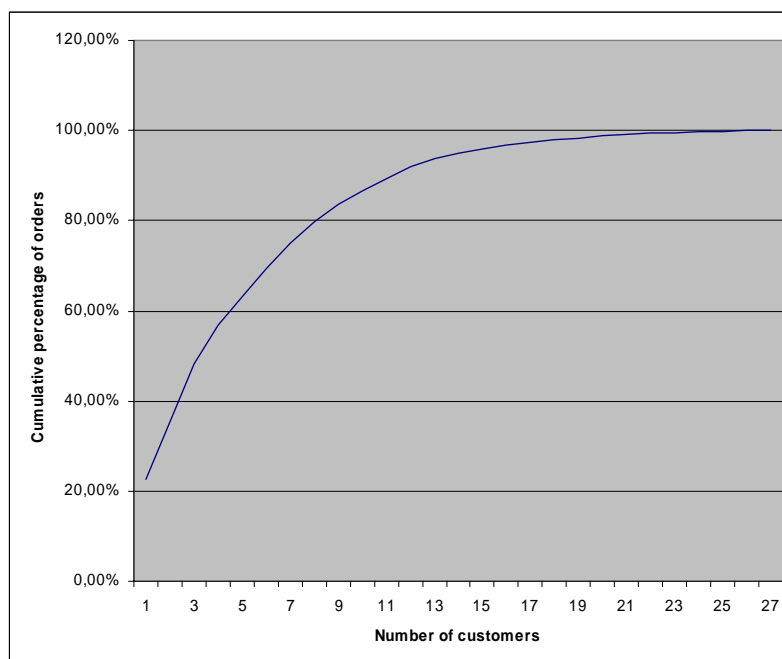


Figure 6 – Customers and their orders

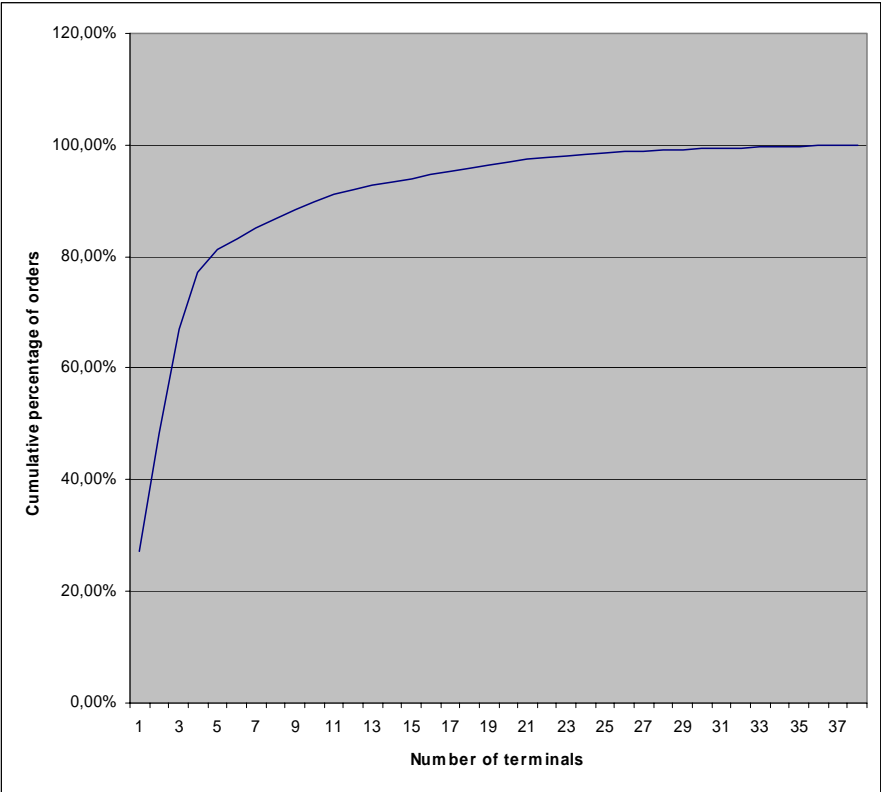


Figure 7 – Terminals and the amount of orders picked-up

Applying Information Integration Theory on the Modeling of Price Forecasting – An Example of Online Trading on Ebay

Hsueh-Foo Lin, Chia-Wei Yang, Ju-hsun Chang

Department of Information Management, National Pingtung Institute of Commerce

51 Min Sheng E. Road, Pingtung 900, Taiwan, R. O. C.

Tel/886-8-7238700 Ext. 6230

Fax/886-7210844

sherry@npic.edu.tw

Abstract: Because of the booming of internet technology and the great promotion internet portal, on-line exchange is more popular in the recent years. This study attempts to integrate concepts of Information Integrate Theory; Anchoring and Adjustment Method to explore the buyer's trade behavior between two different cultures. After observing the historical data on Yahoo's Taiwan and Yahoo's America, the anchoring effect and order effect during the process of a C2C auction is proposed in this study. Chinese buyers seem willing to pay much their attention on pricing during the whole process of an auction than American people do. But, the same phenomenon does exist for American doing a bid on a higher-priced luxury commodity. It sounds for a luxury product, there is a common pricing strategy existed between people of two different cultures. The results provide a very promised direction for knowledge capture and decision analysis for trading, and more works for data mining on pricing for different commodities, cultures, or other kinds of variables related to products and members of market might be a possible future approach for building a knowledge management system for a pricing mechanism for the market.

Keywords: E-service Trading Mechanisms and Market Places; Anchoring and Adjustment Method; Order Effect.

I. Introduction

Questionnaire survey is mostly used to analyze for the studies of physical trading logistic, the on-line trading becomes more popular, which is very different from the physical trading logistic approach in the past and new analysis methods, such as market analyzing, are currently required. Because of the booming internet trade, every country is emphasizing on the development of international internet; however, the differences of cultures do affect the possibility of successful international business. According to the process of trading behavior on the internet, while buyers or sellers offer their negotiated prices, they have often had an initial price in their mind already. The initial price in their mind does refer to the past experience a trader setting up it, and continually presenting some complicated decisions in his brain. Anchoring and Adjustment process in the previous

study is used in this study to model the process of a C2C internet trade and to construct the relationship of a price function and a time sequence functions via a mapping of regressive fitness. So, this study attempts to integrate concepts of Information Integrate Theory; Anchoring and Adjustment Method to explore the buyer's trade behavior between two different cultures. And the historical data of trade on two websites of Yahoo's Taiwan and Yahoo's America is used and analyzed by numerical method.

II. Literature Review

Ackerman [1] reveals the different pricing behavior between Chinese culture and American culture in his physical Logistic study. Graham [6] analyzed the influence of the different cultures on the strategy of negotiation. Clark [5] denoted every country's culture has her unique characteristic. Even many researches have this theory proved, it has no doubt that some scholars also consider the cultural factor is no influence at pricing. Thus, Ackerman explained the reason of no influence at pricing as the culture factor includes too many factors that can't be measured during a complicated pricing negotiation. Comparing Chinese culture with American culture, Jacob [8] pointed out the cultural difference not only has a leading effect on product; but it is actually developed as more influence on the process of trading. Roo's study [10] shows Taiwanese are sensitive to price of personal shopping and tendency of Pragmatism does exist. According to the saving difference in the different countries, the pricing process of trade is very different among the countries they had studied.

Four kinds of pricing were proposed by Wyld [13], they are fixed price, sale price, promoted price, and dynamic price. The dynamic pricing is the one interested in this study. Online pricing is emphasized by incrementing the ability of information swap, electronic commerce is classified four types as auction, haggle, exchange and bidding process. A virtual market as an online auction must have the ability to integrate the demand between buyer and seller, protect the member's right for both side of market, decrease the trading cost and reach the asynchronous of trading target [3]. Based on the difference of degree of involvement for a consumer, the process of his buying decision are very different. A consumer with a higher involvement makes his decision is based on his cognition on a product he wants to buy at first, then changes his attitude gradually before he decides to by it.

But, a consumer with a lower involvement will have his cognition of product firstly, then sooner decides to buy the product, and then changes his attitude of product after buying it.

Payne's research [9] of the structure of human information process addressed that making decision is presented as a function. The effect of decision comes from the characteristic of task itself, such as number of cases, attribute, time pressure and reaction model. A human will refer his belief as an anchoring point, and then try to adjust it with some new information segment. It may be a positive or a negative adjustment. Every new information segment will be combined with an older one to become a new one. It might make the later occurred information having a more weight, thus order effect is happened. More strong points have more effect in the negative information. More weak points have more effect in the positive information [12]. There have two kinds of Anchoring points. The internal point does exist in a decision maker's belief or thought originally. The external point is expressed as common tasks, trade advertisement titles, numbers or texts. Chapman and Johnson [4] denoted a decision maker tends to search some evidences as his decision basis supporting his anchoring point. According to the selective accessibility model, when a human starts to ask and compare, he often is making his selective hypothesis. He assumes that the value of problem is equal to his anchoring point. For example, a bidding participant often applies the market value as his reference point for a target product he is searching for. The hypothesis in his mind is "the initial price is very possible closed to the market price" [2]. The stage of integration and adjustment includes the process from integrating the target and the anchoring point, and then adjusting the anchoring value up to his final decision is made. Information integration theory supporting the reaction of a decision maker can be presented as a function as follows [11]:

$$r_i = w_1 s_1 + w_2 s_2 + \dots + w_i s_i = (1 - w_i) r_{i-1} + w_i s_i$$

r : the decision maker's choice.

w : the weight

s : the estimation of information segment

i : the location of each information.

If a decision maker makes a different weight on each information segment, the order effect will be happened. According to his intuitional rule, a decision maker will start at the first point then adjust to a second information direction in order to precede serial information integration. The lack of adjusting anchoring point is found in the past study [7]. Because a human makes his decision via a psychological process and his behavior does interact with environment. Adjustment of human belief is a serial process of anchoring and adjustment. The original function can be fixed into this situation.

$$r_i = r_{i-1} + w_i (s_i - R)$$

r_i : the belief after receiving information segment i

r_{i-1} : the anchoring point

s_i : the value of information segment

w_i : the weight of information segment i

R : the reference point, it may zero or r_{i-1}

When $R = r_{i-1}$, the function is equal to the last one, but it is different in the symbol w .

III. Research Method

This study attempts to integrate concepts of Information Integrate Theory; Anchoring and Adjustment Method to explore the buyer's trade behavior between two different cultures. So, the historical data of trade on two websites of Yahoo's Taiwan and Yahoo's America is used and analyzed by numerical method. A method with the initial bidding price starting from one dollar is set up to for studying the bidding behavior in an auction for this study. After observing the historical data of trade on two websites of Yahoo's Taiwan and Yahoo's America, the anchoring effect and order effect during the process of a C2C auction is proposed in this study as shown on Figure 1. While a buyer entering the auction website with his own expect price for the bidding product called as a buyer's initial anchoring point. A buyer's initial anchoring point is a reference price point based on his past buying or bidding experience on a related product or process. It is the anchoring point defined in this study. After observing the phenomenon of frequency of offering price on two online trades, Order Effect model is applied to express the process of adjustment between buyers and sellers. In other words, while the bidding desire is increased by a positive effect, then they will try to show up online to offer a higher price frequently and to communicate more often in the bidding product information searching or pricing strategy suggestions on the discussion panel. On the other hand, while a negative effect does occur on a buyer, he might despair or post some negative on the broad. And each bidding price shown on the broad is a market price to a new entering buyer, and it will be an anchoring point to a new entering buyer. So, these bidding reference are dependent and related to each other, the order effect of positive or negative is continuously demonstrated during the whole bidding process for an online auction. It is more quickly and transparent than that for a traditional action. Due to the difference of degree of involvement on a bidding product, a process of anchoring for the pricing sensitivity would distinct into a buyer as a general buyer or an expert. A bidding product can be classified into general, specialty and luxury based on the degree of involvement. Using Information Integration Theory proposed by Anderson to integrate the on-line continuous segments of time series with the segment of entering the process of an auction. And the initial and current effects were shown on a graph and an equation using the statistic method to test its curve.

Therefore, the bidding decision of a series of buyers, as the order entering points of segment were corresponding to function of time with a different weight, can be equated into a pricing curve as the following model. The definition of parameters in the model is described as follows:

$$Y_x = C + W_i Z_x^i$$

$$Z_x = C + V_j X_k^j$$

$A\{X_1, \dots, X_k, X_n\}$: A set of sequence order for n persons in an auction process.

$B\{Y_1, \dots, Y_k, Y_n\}$: A set of bid price from persons in the process.

$T\{Z_1, \dots, Z_k, Z_n\}$: A set of the entering time point of a person for an auction process.

$W\{w_1, \dots, w_i, w_n\}$: the weight of variant in a pricing function, $i=1, 2, \dots, n$

$V\{v_1, \dots, v_j, v_o\}$: the weight of variant in a time sequence function, $j=1, 2, \dots, o$.

X_k : the k th person in Set X , $k=1, 2, \dots, p$.

Y_k : the bid price offered from the k th person.

Y_0 : the initial price offered from the seller.

Z_k : the entering time pint of the k th order.

Z_0 : the ending time point set up by the seller.

W_i : the i th weight of a pricing function

V_j : the j th weight of a time sequence function

C : Constant

Pricing Function $Y=G(Z)=G[F(X)]$

Time Sequence Function $Z=F(X)$

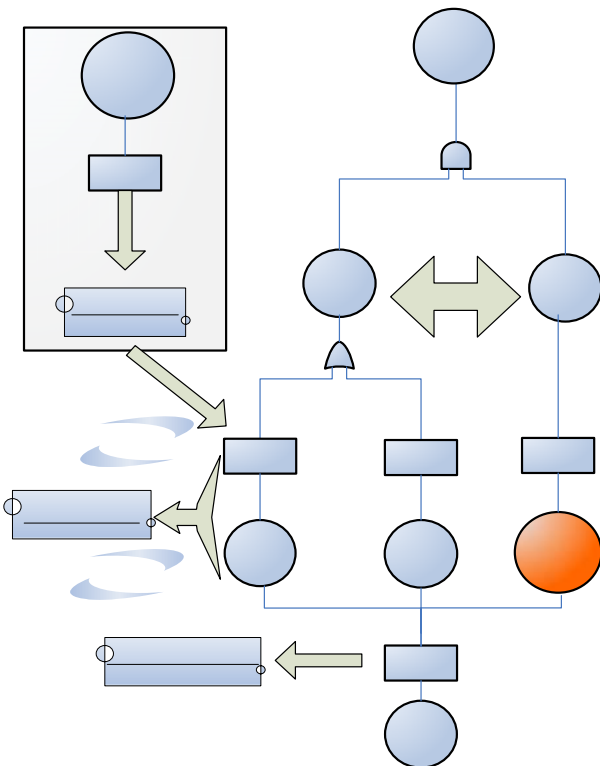


Figure 1 Anchoring Effect and Order Effect during a Process of a C2C Auction

IV. Research Result and Discussion

Using the equations defined in the model, six sets of historical data classified as general, specialty-pro, and luxury-higher price within two counties are applied for running the fitness test, and fitting into linear distribution, exponential distribution, square function with one unknown variable, cubic function with one unknown variable and logarithmic function. Functions with R-square > 0.9 explanatory power were chosen as the results are shown as Table 1, Figure 2 and Figure 3. Based on Bayer's Rule and order effect, the reference point of an initial bidding was reflected on the pricing while a buyer entering into the process of trade as shown in Figure 3. Comparing on the difference of culture, the degree of pricing participation of a Chinese is higher. Chinese buyers seem willing to pay much their attention on pricing during the whole process of an auction than American people do. But, the same phenomenon does exist for American doing a bid on a higher-priced luxury commodity. It sounds for a luxury product, there is a common pricing strategy existed between people of two different cultures.

V. Conclusions

The findings of this study reveal the equations of a function of pricing related to anchoring and adjustment and a function of time sequence of bidding related to order effect can be constructed via the historical data from the data base of trading on the Internet. The phenomenon of trading online does demonstrate the human's cognitive behavior. And the decision making on a bidding price online between Chinese and American are different, and there is a common decision behavior existed for some kinds of commodities too. The results provide a very promised direction for knowledge capture and decision analysis for trading, and more works for data mining on pricing for different commodities, cultures, or other kinds of variables related to products and members of market might be a possible future approach for building a knowledge management system for a pricing mechanism for the market.

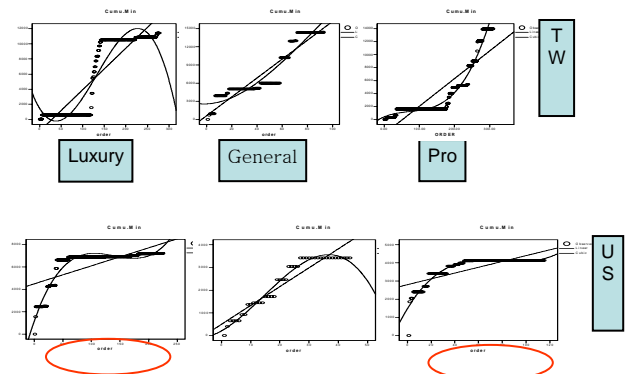


Figure 2 Relationship of Time Sequence Function

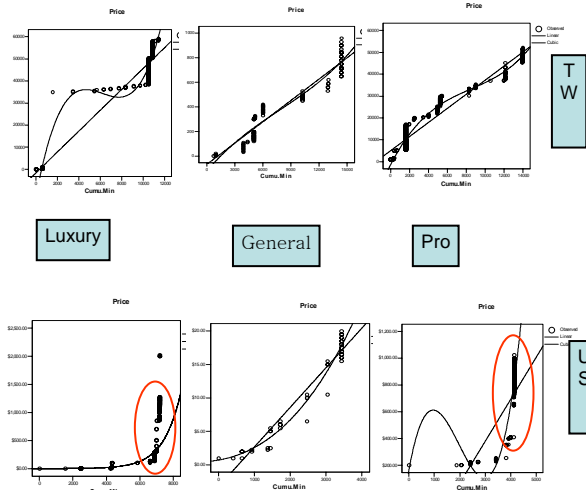


Figure 3 Relationship of Pricing Function

Table 1 Equations of Y and Z for Six Data Sets

Taiwanese Website: TW-Yahoo	
Luxury Commodity-Supper High Price	
$Y = -13052 + 26.2938Z - 0.0045Z^2 + (2.4E - 7)Z^3$	
$Z = 1481.56 - 94.358X + 1.444X^2 - 0.0036X^3$	
General Commodity - low Price	
$Y = -122.88 + 0.0899Z - (5E - 6)Z^2 + (2.1E - 7)Z^3$	
$Z = 2580.72 + 7.9633X + 2.3137X^2 - 0.0088X^3$	
Specialty-Pro	
$Y = -1456.5 + 8.4267Z - 0.0008Z^2 + (3E - 8)Z^3$	
$Z = 400.9 + 22.6372X - 0.2345X^2 - 0.0011X^3$	
American Website: US-Yahoo	
Luxury Commodity-Supper High Price	
$\ln(Y) = 0.4177 + 0.001Z$	
$Z = 1153.93 + 143.835X - 1.0958X^2 + 0.0026X^3$	
General Commodity - low Price	
$Y = 0.7037 + 0.0010Z + (8.2E - 7)Z^2 + (1E - 10)Z^3$	
$Z = 205.899 + 72.1357X + 3.5368X^2 - 0.0820X^3$	

Specialty-Pro

$$Y = 166.98 + 1.0483Z - 0.0007Z^2 + (1.2E - 7)Z^3$$

$$Z = 1482.12 + 106.367X - 1.3698X^2 + 0.0057X^3$$

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A Mining-Based System Framework for Deploying Knowledge Maps of Composite E-Services

Jia-Yuan Lee, Chun-Feng Lee, Chih-Kun Ke, Duen-Ren Liu
Institute of Information Management
National Chiao Tung University
Hsinchu 300, Taiwan
E-mail: clay@iim.nctu.edu.tw

Abstract: Providing e-services and composite e-services on the Internet is an important trend of e-business. Composite e-services are complex processes which consist of various e-services provided by different e-service providers. In such complex environments, the flexibility and success of e-business depend on effective knowledge supports to access related information and resources of composite e-services. This work proposes a knowledge map platform to provide an effective knowledge support for utilizing composite e-services. A mining-based system framework is proposed to construct the knowledge map. Moreover, the proposed knowledge map is integrated with recommendation capability to provide users customized decision support in utilizing composite e-services.

Keywords: Dynamic E-service Discovery, Composition.

I. Introduction

With the explosive growth of Internet, more enterprises are providing various e-services for collaborative commerce online to achieve competitive advantages. Composite e-services are complex processes that require the cooperation among cross-organizational e-service providers. In such complex collaborative commerce environments, online user is facing the difficulty of how to select the appropriate composite e-services that suit their needs. Accordingly, an effective knowledge support system is essential to organize and access related information resources in e-service environments.

Many researches have focused on dynamic composition of e-services and system platforms to provide composite e-services [2][4][16][17]. Casti and Shan [4] proposed a model to compose e-services dynamically. Balakrishnan [2] proposed a Service Framework Specification to compose e-services. Several e-service platforms are proposed, for example, HP e-speak [10] and Microsoft .Net [15]. Basic features of these platforms are registering, advertising, monitoring, and managing e-services. However, conventional e-service platforms do not provide effective knowledge supports for managing information resources of composite e-services.

A knowledge map is a visual display of captured information and relationships, which enables efficient

communication and learning of knowledge [20]. Knowledge Maps have been used by enterprises to manage and navigate enterprises' explicit knowledge [5][7][12]. Accordingly, this work proposes a mining-based knowledge map platform to provide effective knowledge supports for utilizing information resources of composite e-services.

A data mining approach is employed to extract knowledge patterns from the usage records of composite e-services. The extracted knowledge patterns, which represent the important subjects and associations of composite e-services, form the kernel of the knowledge map. A topic map standard [11] was adopted to develop the proposed knowledge map, providing a bridge for managing and exchanging heterogeneous resources of composite e-services. Meanwhile, the proposed knowledge map is integrated with recommendation capability to generate recommendations of composite e-services via data mining and collaborative filtering techniques. The proposed knowledge map enhanced with recommendations can provide users customized decision support to effectively utilize composite e-services.

The rest of this paper is organized as follows; Section 2 introduces related work. Section 3 describes the proposed system framework. The architecture and functionality of the system are illustrated in Section 4. Section 5 presents the integration of recommendations. Section 6 demonstrates the prototype system. Conclusions and future works are finally made in section 7.

II. Related Work

Web services and composite e-services. Web services and e-services are similar but Web services place an emphasis on Web technologies. UDDI, WSDL, and SOAP, have been accepted as the de facto standards for Web services [20]. Composite e-services are composed by several e-services, and, intuitively, it can be seen as a workflow. Casati and Shan proposed a dynamic model for composing e-services [4]. Piccinelli and Williams [17] presented a DySCo infrastructure that uses a workflow model as a basis for composing Web services.

Knowledge maps. Successive knowledge map applications take advantages of the nature of visualization and navigation to locating and publishing knowledge [6]. Chung et al. [5] proposed a knowledge map framework for discovering business intelligence to alleviate information overload on the Web. Lin and Hsueh [14] applied information retrieval algorithms to generate and maintain a

knowledge map for virtual communities of practice. Kim et al. [12] proposed a road map to develop knowledge maps in the industrial community.

Topic Maps and XTM. The ISO standard ISO/IEC 13250 Topic Maps defines a model for the semantic structuring of link networks [11]. Topic Maps provide a bridge between the domains of knowledge representation and information management and link it to existing information resources. XML topic maps (XTM) [19] specified by TopicMaps.Org is an abstract model that uses XML grammar to express Web-based topic maps.

Recommendations. Collaborative filtering (CF) [3] has been successfully used in various applications [8][13][18]. The CF method utilizes preference ratings given by various users to determine recommendations to a target user based on the opinions of other similar users. Users' preference ratings are used to compute correlation coefficients among users. The correlation coefficient is a measure of the similarity between two different users' preferences.

Data mining. Data mining involves several tasks for different mining purposes, including association rule mining, clustering, classification, prediction, and time-series analysis [9]. K-means is a method commonly used to partition a set of data into K groups. Association rule mining aims to find an association between two sets of products in the transaction database [1]. The support of an association rule indicates how frequently that rule applies to the data. The apriori algorithm [1] is typically used to find association rules by discovering frequent itemsets.

III. System Framework of Kmap Platform

The proposed knowledge map (Kmap) platform includes two main sub-systems: knowledge map system and recommender system, as shown in Fig. 1.

III.1 Knowledge map system

The system includes four main modules.

Service collecting and planning. This module collects e-service information provided by various e-service providers. Predefined composite e-services are stored in the system. Moreover, the module generates service plan templates to assist users sketch a composite e-service.

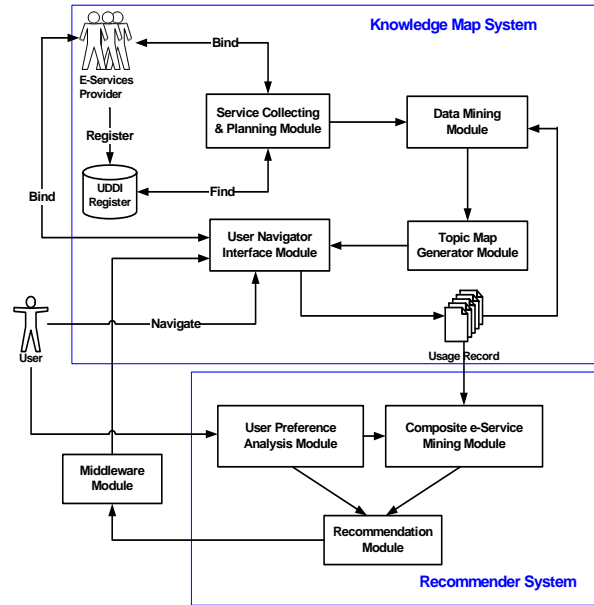
- **Data mining.** Data mining techniques are employed to discover valuable knowledge patterns from usage records and meta-information of composite e-services. The usage records log the historical executions of composite e-services conducted by various users. Important subjects (topics) and their associations of composite e-services are discovered via clustering and association rule mining techniques.

- **Topic Maps generator.** To facilitate knowledge exchange and sharing, XTM (XML topic maps) is employed to construct the knowledge map. The discovered knowledge patterns, including the valuable

subjects and their associations, are used to form the topics and topic associations of the knowledge map.

- **User navigator interface.** This module provides a navigator for user to browse composite e-services and related knowledge patterns by using the XTM-based interface.

FIG. 1. System framework of the Kmap platform



III.2 Recommender system

The proposed Kmap system can recommend the frequent attributes of each basic e-service, the ordering between e-services, and the composite e-services. Group-based recommendations are supported via analyzing the usage behaviors of interest-groups. Collaborative filtering is employed to recommending e-service providers for selected e-services.

- **User preference analysis.** This module uses *pearson* correlation coefficient to compute the similarity between users based on user's preference ratings on e-services served by various providers. The *k-NN* approach is used to derive a user's neighborhood (similar users). Moreover, a clustering approach is employed to cluster customers into interest-groups based on similarity measures.
- **Composite e-service mining.** This module uses association rule mining approach to discover *frequent attributes* of each basic e-service and *frequent ordering* between e-services from the instance execution logs. Moreover, the mining can also be conducted via considering the usage records of interest-groups to discover group-based frequent attributes and frequent orderings.
- **Composite e-service recommendation.** A scoring approach is used to recommend the top *N* composite e-

represented in vector space model. A composite e-service's vector contains the meta information of a composite e-service and the union of all the vectors of basic e-services included in the composite e-service.

Calculate the dissimilarity. This work uses Euclidean distance measurement to compute the proximity distance between pair-wise vectors. The Euclidean distance measures the dissimilarity between two composite e-services.

Form clusters. The K-Means clustering technique is employed to perform clustering in which Euclidean distance is used to measure the dissimilarity between composite e-services.

Determine the important topics. A cluster centroid is extracted to represent the major attributes of a cluster of composite e-services. The frequently appearing attributes will form the cluster centroid. The extracted important attributes of a cluster centroid form the topics in the discovered knowledge map of composite e-services.

IV. 3. 2 Mining association patterns

This work employs *apriori* algorithm to find association patterns, namely frequent topic sets, from the usage records and meta information of composite e-services within a cluster.

Association patterns of basic e-services. Such association patterns are discovered via applying association rule mining to the usage records of e-services. The association patterns mainly consist of associations between attributes which are derived from the frequent attribute sets of the mining result. Each attribute corresponds to a topic with a defined topic type in XTM. The associations among several types of attributes can be discovered. The association: Instructor "Nancy" \leftrightarrow Difficulty "Basic" implies that the instructor "Nancy" often lectures courses with "Basic" difficulty.

Association patterns among composite e-services. Such association patterns are discovered via applying association rule mining to the usage records of composite e-services. The association patterns mainly consist of associations between attributes or e-services which are derived from the frequent attribute sets of the mining result.

IV. 3. 3 Recommendations by association patterns

The association patterns imply relevance relationships between topics, and can be used to recommend relevant topics during users' navigations of the knowledge map.

IV. 4 Topic Maps generator

This module generates the knowledge map of composite e-services in XTM documents based on the mining results. The important attributes of basic and composite e-services extracted from each cluster form the topics in XTM. Association patterns discovered from association rule mining form the topic associations. The association type "Relevance" is used to record the association patterns discovered from the mining results. The association type

represents the relevance relationship between e-services or service attributes. Several kinds of attribute associations can be discovered via association rule mining, as described in Section 4.3.2.

V. Recommender System

The recommender system implements two approaches to generate recommendations: collaborative filtering and association rule mining.

Group-based recommendations. The recommendation can be conducted by considering interest-groups to provide group-based recommendations. Customers with similar preferences are grouped into interest-groups. For a customer *u*, the group-based recommendation proceeds as follows. The instance execution logs of *u*'s interest-group are used to discover the frequent attribute sets of e-services and frequent ordering sets between e-services. Such discovered frequent attribute and ordering sets are then used to derive the scores of composite e-services and make recommendations.

E-service provider recommendations. Collaborative filtering (CF) approach is used to recommend e-service providers for the selected e-services. The CF approach finds the *k*-nearest neighbors (most similar users) of *u*, and then makes recommendations via considering the *k*-nearest neighbors' preferences on e-service providers and their similarity to *u*. Through the user's *k*-nearest neighbors, the system can predict user's preference on an e-service served by a particular provider.

VI. System Implementation and Demonstration

The implementation is conducted using several software tools, including ASP .NET(C#), JSP, Microsoft Visual Studio .NET and Borland J-Builder. Web server is setup on Microsoft IIS 6.0 and Apache Tomcat 5. Microsoft SQL server 2000 is used as the database system for storing related data of e-services and composite e-services. Microsoft UDDI Service is used as the UDDI engine for e-service search and registrations. Moreover, the data mining tool - Weka 3.4 is employed to discover the knowledge patterns as well as frequent attribute and ordering sets of composite e-services. The XTM files for storing the discovered knowledge patterns including topics and associations in each cluster is generated according to the XTM defined in section 4.2 and 4.4. ASP.NET is employed to develop the Web-based navigator which allows users to browse and navigate the XTM information of composite e-services. The Kmap system is integrated with the recommendation capability to provide more effective knowledge support for managing and browsing composite e-services.

System demonstration. The Kmap navigator shows the clusters of composite e-services with attributes of cluster

centroid attached. Once a user selects a cluster to browse, the attribute values of the selected cluster can be browsed further in the navigator. User can browse the topics in the navigator through topics of clusters, "RelateTo" and "Relevance" associations. Once a user selects an e-service "Programming a MS SQL Server 2000 Database", the χ map system displays the detailed information, as shown in Fig. 3. The relevant e-services are also suggested to provide further navigations of relevant e-services. When a user Mike logs in, the system identifies Mike's interest-group. Mike browses the cluster A of composite e-services to decide needed services. The navigator provides the recommended composite e-services which are derived from the usage records of composite e-services conducted by Mike's interest group. Mike can click on any e-service in selected composite e-service to obtain the details (frequent attribute values) of the clicked e-service. The system can also suggest providers to serve the e-service via the collaborative filtering approach.

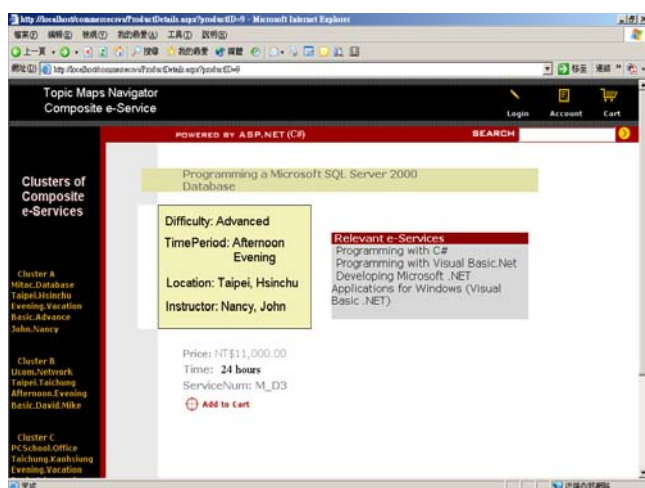


FIG. 3. Navigation with relevant e-services

VII. Conclusions

This work mainly develops a χ map system to provide knowledge supports for browsing and managing composite e-services. Data mining techniques are employed to discover valuable knowledge patterns of composite e-services. The discovered important subjects and association patterns are used as the kernel to generate the knowledge map. This work employs the XML topic maps to construct the knowledge maps of composite e-services. Consequently, the knowledge maps of composite e-services, expressed in XML Topic Maps, can be exchanged and interoperated more easily on the Internet. Effective collaborations of conducting composite e-services over the Internet can thus be facilitated. Moreover, the proposed system provides integrated browsing and recommendations of composite e-services. The proposed knowledge map enhanced with recommend-

ations can provide user customized decision support to effectively utilize composite e-services.

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Instructing with Advanced Collaboration Technology: Lessons Learned and Unexpected Transformations

John T. Nosek
Temple University
609-605-9273 nosek@temple.edu

Abstract: This paper provides lessons learned and some unexpected transformations in the learning process when advanced collaboration technology was used to overcome limitations of a popular, existing collaboration technology. The activities pursued in these advanced undergraduate and graduate computer and information sciences courses replicate many of the activities in collaborative knowledge work in organizations. Therefore, the lessons learned should be applicable to transforming other kinds of joint knowledge work in general.

Keywords: Collaborative Learning; Collaborative Support Systems; Collaborative Technologies; Collaborative Work Systems; Collaborative Writing; Electronic Collaboration; Knowledge-Based Systems; Learning.

I. Introduction

This paper describes the use of advanced collaboration technology to improve instruction and how such technology can transform the learning process in unexpected ways. The activities pursued in these advanced undergraduate and graduate computer and information sciences courses replicate many of the activities in collaborative knowledge work in organizations. This paper discusses the limitations of a popular, existing collaboration technology which propelled us to try something new; discusses the co-development of joint artifacts; describes the new technology used; and explores lessons learned and some unexpected transformations in the learning process which should be applicable to transforming other kinds of joint knowledge-work in general.

II. Problems with Current Collaboration Technology

While there is overlap in functionality in collaboration technology, and these technologies can be used in a complementary fashion, it is useful to divide collaboration technology into three categories:

- ⇒ Technology that overcomes the limitation of people not being in the same time at the same place where they can meet face-to-face and can share common artifacts, such as documents. This includes real time technology such as Instant Messaging; web-, video- and tele-confer-

encing; and application sharing, such as Microsoft's Net Meeting. This also includes asynchronous technology such as email, email and attachments; shared folders on LANs and the WEB; and chat and threaded discussions.

- ⇒ Technology that assists in the co-development of artifacts. Specifically, technology that helps to overcome the social, cognitive, and procedural complexities in planning, creating, evaluating, negotiating, and consolidating joint artifacts.
- ⇒ Technology that assists in the coordination of tasks that can be completed independently but are interrelated to others. This includes workflow and project management technology.

Most collaboration technology seems to be stuck in trying to overcome the limitation of people not being in the same place at the same time [3, 6]. Blackboard™, an electronic version of a blackboard, is a popular collaboration tool used in education that fits within this category. Blackboard™ is the typical portal-based architecture that is mostly used to store various artifacts, such as syllabi, class documents, and presentations; and has little-used add-on tools, such as chats and threaded discussions. In Blackboard™, if one wants access to a document for displaying to and updating by a class, one must typically do the following: 1) navigate to the document through a series of Web pages; 2) download it; 3) navigate to the downloaded location; 4) open it up in the application; 5) modify it; 6) save it to the file system; 7) delete it in Blackboard™; and 8) re-add it to Blackboard™. While the document is available for viewing, the document cannot be jointly edited. This makes it all but useless in real-time and asynchronous interactions. In addition, Blackboard's functionality reinforces a prevailing notion that course documents are static. Is there something limiting in Blackboard's conceptual view of collaborative support as essentially providing a common depository for static artifacts that affects its design and usefulness [6]?

III. Co-development of Work Products within a Collaboration

There must be an intellectual break away from the notion of individual tools that incorporate collaboration functionality in a non-integrative fashion [6]. Joint work products that evolve as part of the sensemaking process include such things as plans, reports, budgets, specifications, architectures, contracts, designs, and software code. Technology must

support all phases [5, 8]:

- **Planning.** Collaborators establish the objectives, structure, and divide up parts of the shared work product to be created.
- **Creation.** Collaborators compose their portion of the joint work product. Although they may work alone, it is important that they are aware of what the other collaborators are doing.
- **Evaluation.** Collaborators review, propose changes, and add comments to each other's work.
- **Negotiation.** Collaborators discuss proposed changes with one another and decide on what changes should be made.
- **Consolidation.** The collaborators resolve conflicts and merge changes into the shared work product.

IV. Transformations to Instruction and Learning

One class is a senior-level, two-semester undergraduate course where groups of students create real information systems for real-world clients; the other class is a graduate course in human usability design. Much of the instruction focuses on experiential learning and deals with the co-development of information system artifacts for a given problem scenario over the course of the semester. Students are then tested in skill-based practical exams and teams apply these skills to design and develop real-world systems. This section describes the evolution of a better understanding of the process of co-development of joint artifacts and the unexpected transformations in the learning process that occurred as a result of using SenseMaker™.

Assessing Progress and Individual Contributions

Universally, instructors who employ demanding group projects find assessment of group progress and individual contributions within the projects difficult. SenseMaker™ can help mitigate these assessment issues by viewing work-in-progress and identifying individual contributions within overall group effort.

Transition Between Asynchronous and Synchronous Interactions Within Class

For the most part, the common notion of class is that an instructor interacts synchronously with his or her students. Usually the class breakout into project teams to work asynchronously. They then post solutions in SenseMaker™ to support transition back to synchronous interaction.

Peer Learning and Transition Between Asynchronous and Synchronous Interactions Between Class

This is similar to within a class, but more pronounced. A major problem in following a problem in-class throughout the semester is the problem of providing some way for the groups to continue to work on the problem between classes and then pick-up with some progression in the next class –

one can't easily save what each group has done on the board or project what one's solution is to the problem.

Several features of SenseMaker™ were invaluable to this process:

- ⇒ **Subdividing.** Artifacts could be subdivided and then assigned to teams to work on in parallel with other subdivisions by other team members. This permitted teams to work on their section and also see how other teams were progressing in their solutions. This also permitted progress on the solution as a whole.
- ⇒ **Suggesting Alternatives.** When class convened for the next section, some group's solution would be displayed to the class. As a class we could review the solution. However, instead of making changes directly to the solution, using SenseMaker™ an alternative can be suggested. This means a copy is made and linked to the original solution. Then, as a class, we could work on the alternative together and save it. Students have available the original result of their thought processes and the corrected version. In this manner, the differences of their understanding and the solution are always available for review.

This process meant almost the complete elimination of the use of the whiteboard in class and Blackboard™ in general. All work was created and available for use by the class. Since exams were practical exams to demonstrate learned skills; some students either downloaded the joint artifacts to their own notebooks for use during the exam, while others made hard copies. In the future, we intend to provide wireless access to SenseMaker™ artifacts during classes, including exams.

Co-development of Joint Artifacts

The enhanced features of SenseMaker™ provided “controlled” co-development of project submissions required of each team. Project teams could subdivide submission documents and work in parallel.

Joint Evaluation

SenseMaker™ permits parallel evaluation where instructor, teaching assistants, and students interact to understand each other to achieve satisfactory evaluation. In situations where the artifacts are created based on some interpretation, the feedback of the creator may be critical in understanding the thought processes. Instead of a black hole until the graded submission is returned, the student can see the evaluation in progress and even provide feedback to assist in the evaluation.

Virtual Nods (vnods)

An assumption behind most collaboration technologies is that face-to-face is the best medium and one must use technology to overcome the limitation of not being able to collaborate in person [1]. However, there is growing evidence that face-to-face interaction may not always be best

[2, 4, 7]. In an effort to incorporate motivational characteristics of face-to-face interactions within asynchronous interactions, SenseMaker™ records the date and time a participant “virtually nodded” by reviewing some content. In addition to the motivational benefit of virtual nods, Vnods within SenseMaker™ helps to controls interaction feedback in a number of ways: First, it eliminates countless numbers of emails that would be needed to incorporate virtual nods on ideas or comments; Second, the instructor “pulls” the information when needed by easily reviewing who in the project/class has visited some content; Third, there is functionality within SenseMaker™ for the instructor to easily “push (send email)” to request a vnod from the whole group or from the subset who has not yet vnodded on something.

Rethinking What is Static and Dynamic

With current web technology that provides the ability to post, there is an implicit assumption that the posted documents are static. For example, prior to using SenseMaker™, a syllabus seemed like a static document that was distributed or posted. However, the syllabus is far from static. The schedule can change. Students can have questions as to what is meant by some aspect of the syllabus. There could be errors in the original syllabus. Using SenseMaker™, the syllabus was subdivided into major subsections and these further subdivided as necessary. When a change was made to a section, only that section was updated. In the usual process, the complete syllabus would be deleted from the website, modified, and then reposted. In lengthy syllabi, it is unlikely that the student will take the effort to see the change; and without vnods, there would be no way to ensure whether the student is aware of the change. In another example, a student posted a question by attaching the question to a particular section. The response was made by the instructor and the section modified. Other students could see the question, the response, and the modification. Through the use of vnods, the instructor can see who saw the question, the response, and the modification. Finally, one can make questions that students have about the syllabus a positive experience. For example, students, who question the clarity of some wording in the syllabus, are encouraged to use SenseMaker™ to suggest alternative wording. This provides an opportunity to provide feedback to improve the syllabus and students gain practice in writing in a more clear style. Those students who provide such feedback can be awarded with extra credit.

V. Summary

Incorporating collaboration functionality in a piece-meal approach as add-ons within a portal-based architecture can limit the potential of collaboration technology to transform joint work processes. This paper discussed the limitations of a popular, existing collaboration technology which propelled the use to try more advanced collaboration technology. The co-development of joint artifacts was discussed and SenseMaker™ functionality was presented. The activities pursued in the advanced undergraduate and graduate computer information science courses replicate many of the activities in collaborative knowledge work in organizations. Therefore, the lessons learned should be applicable to transforming other kinds of joint knowledge work in general.

VI. Trademarks

SenseMaker™ is a trademark of SenseMaking Technologies Corporation. Blackboard™ is a trademark of Blackboard Corporation.

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A Qualitative Analysis of Emerging E-Commerce Technologies and Their Effects on Changing Business Patterns

Nadir Ali Kolachi
Institute of Management & Computer Sciences
Bahria University, Karachi, Pakistan
nadir@bimcs.edu.pk
nadir.kolachi@gmail.com
Cell: No: 0320-2010004

Abstract: Technology of different shapes have got much race from 1960 to present. In 1970, the computer technology brought lots of faster modes of business when the faster calculations and saving data became possible. It further innovated the big information systems after 1985 when the manual work started to be converted into computerized means as computer based information systems. But one advent brought various solutions to the business and that is the miraculous advent of internet after 1992.

An internet is one of the biggest emerging Ecom technology which has facilitated the business platform in much faster and flexible standards. Due to the technology the business is advanced at an exponential rate of making life very easy and guiding to be equipped with other technological wonders of not only doing business but increasing education activities, knowledge and coordination through organization to organization and customers to customers.

The purpose of this paper is to identify emerging e-com technologies and get a sneak peak into internet and information literacy related technologies which will pull e-com any time to millions of people and push business to survive on modern business platforms. The study will focus on emerging e-com technologies that have emerged through the last decade or so. It will also focus on the current and possible applications and factors of important view which have brought significant role in business scenario.

The paper consists of five main sections: First is about the introduction, concept and definitions of the topic, Second is regarding the historical perspective of emerging technologies and identification of e-com emerging technologies and their changing phase in the faster pace of information technology and business aspects, Third focuses on the model of e-com and computer technology development. Fourth is about some examples on applications of emerging e-com technologies from available literature survey to support this research, Fifth is followed by the conclusions, recommendations, research methodology, references and bibliography.

Keywords: Emerging technologies; e-commerce an changing business patterns

I. Introduction

History of technology development is long story of electronic business affair but following are some of the important icons which initiated and proposed the emerging technologies development in an IT age.

EDI (Electronic Data Interchange)

EDI concept is the in the emergence since 1960 in US specially. A group of railroad companies concerned with the quality of inter-company exchanges of transportation data formed an organization to study the problems and to improve it. This organization was known as the Transportation Data Coordinating Committee (TDCC). EDI has always been in the help of better business but its high cost standards are complicated and its huge complexities in the application has hindered the EDI popularity in the business. But after the advent of an internet, it is a bit popular as internet EDI activities towards business processes.

Internet & Web.

The internet pushed many companies to be connected with their suppliers, customers and competitors in particular for the purpose of better business activities. This push compelled companies to have web existence to have an edge in miraculous innovations of information technology platforms.

XML and Web service.

XML provides a development tool for defining format of the data interchange in a wide variety of business communities where web service offer an effective architecture for the business and communication initiatives. An XML and Web service are shaping in a very effective manners to all e-com technologies.

DSL

DSL brought an exponential growth in the world of e-com due to its twenty four hours communication across the world. This provides digital communication on copper wire of the local telephone network. This was announced in California 1998 but it has also a unique history when an engineers at Bell research lab devised a way to carry a digital signal over the unused frequency spectrum in 1988 but it got much popularity after the faster pace of electronic business

scenario.

M-Commerce.

The development in mobile and portable gadgets created very easy and flexible platform for companies to provide all commercial activities at their time. Mobile commerce is an extension concepts of e-com which provides the all same facilities in mobile means. This concept was the result of the boom in dot com companies which brought lots of communication on the applications via broad band mobile telephony

II. Online Scenario

In this process, an online ticketing, online banking, online selling and all the results of advancement in networked devices and web services became common phenomena. This became much popular after the areas of internet and had become ubiquitous. The banking sector is much benefited by e-com concepts, the same is the case with trading, companies having an online trades etc. The ATMs facility of banking sector is one of the emerging technologies which is being adopted by almost every body.

Technology has always been a great influence on the business patterns because of its innovation and advancement in inventions. There are lots of technological icons which are responsible to modify the methodology of business trends but computer related technologies are the major controlling icons on the world's business desktop.

Following technologies are considered as important factors.

Computer Technology (Software Based)

- Information Technology
- Information Systems
- Information Superhighways
- Information Literacy
- Information Layers

Computer Technology (Hardware based)

Computer Systems

- IT Systems
- Machines
- Man-Machine Interface
- Network Gadgets
- Communication devices
- Mobile Phones

Business Related Technologies

- Electronic Commerce
- Electronic Business
- Electronic Marketing
- CRM
- ERPs
- SCMs

The changing business patterns are the results of customers' knowledge and preferences. The customers who are information literate and have an access to modern communication methods can check the competitor's

products and order them to get products with in no time. Such thing pushes the organization to change the outdated business styles but adopt the one which is most compatible with the needs of the country.

The major changes occurred because of the following business and technological flow which mainly started after 1970 with the introduction of microchip which brought lots of capacity of maintaining and preserving customers data, faster calculation and accurate methods. This other change submerged when the information systems go much popularity of changing manual information systems towards computer based information systems.

The third one which brought lots of other changes and turned the world into one village was the miraculous advent of internet. This technology facilitated the business organization to have web existence and ubiquitous scenario. This gave birth and flourished other wonderful emerging concepts of emerging technologies.

The technologies like electronic Business, electronic commerce, and mobile business and commerce. Such flexible and worldly available facility convinced many organizations to work for eruptive and disruptive concept of technologies and started to produce not only one product line but to come up with multiple product line offerings. For example, companies who were doing internet facilities came up with software, information system packages, providing compatible machines etc.

In this way the competitors started and all companies dived into the domain of designing strategic packages and acceptable product differentiations having an hawk's eye on the competitors strategies and predictive plans. Such competition brought a very good flow of choices for the customers and the power which was with the sellers shifted to buyers because of the countless choices in every domain of items.

Despite of tremendous accomplishments of internet and communication technologies, it has also been observed that world's major business activities depend on full integration of the globe.

Customers know the product but want to reach it with in no time. In this way, companies look for such kind of solution that can satiate the need of the customers immediately, that's why companies joined the party of major business trends which include greater pervasiveness of computers continuing convergence of computing and communication, greater automation of work, faster pace of business, accelerating global competitiveness and gradual acceptance of global standards.

Following is the model which explains the trend of technology from 1960 to present indicating the changing business patterns due to the advancement in computers, information technology and e-commerce which created a base for emerging definite technologies named as emerging e-com technologies.

Technology	Years	Emerging Technologies	Business Patterns
MRP MRP-II	1960s	EDI	Coordination, Simple processes In HRM and Engineering
Computers Microchip	1970s	EDI, Terminals and Computers	Faster processes, Faster calculation Methodology improved
Information Systems	1980s	Information Systems, MIS, CBIS, ESS, and DSS	Manual Information, Coordination and other business activities, communication flow from first line to middle and top level managers
Internet Electronic Commerce	1990s	Internet, TCP/IP, WEB services, DSL, Gateways SSL and SET	Modern information Systems (ERPs), Global village, World connectivity, World coordination, Online business, CRM and SCM.
Mobile Commerce	2000 to present	Wireless, WAP Mobile technologies Micro browsers	Mobile business All activities of e-com into the mobile means
Eye Blinking Business	Future	Eye rays Eye as an infrared	The time will come when a man will blink and the transaction will happen.

The model explains the historical background of technology identifying the pace by emerging technologies which pushes to flat the business patterns in different organizations and countries.

In 1960, when the MRP (Material Requirement Planning) was being used for the purpose of coordination at smaller level in the organization and the usage of EDI was possible at that time but at lesser scale. After a while it got much advancement in coordination patterns and expanded from coordination towards faster process and faster communication

The 1970s is the most memorable time because of the introduction of micro chip which exploded the world

computer technology and provided us with the faster pace, faster calculation devices and methodology of other fields was improved at satisfactory level. In this time, the EDI was also in use.

In 1980s, the time of information systems got much popularity when the manual information systems were converted into computer based information systems and many middle managers started using MIS, DSS and some ESS to know the complexities of maintaining data and communicating to top level hierarchy for structured and unstructured decision-making

The year 1992 is the most historical icon because of the miraculous and God gifted innovation of Internet which brought all human being together all over the world and people started sharing data, retrieving information and knowing what is being done in other countries of the world. This brought lots of concepts of information superhighway and technology which also facilitated the platform for electronic business using TCP/IP for simple communication and SSL & SET protocols for secure business transactions. This got world connectivity, communication, better relationship and reaching customers within seconds.

The era of 2000 and onward is the era of mobile connectivity, all which is possible by e-com and is converted into mobile means because of the advancement in universal mobile communication technologies.

Every time, whenever we get across with the technology innovation, we come across to know that another small form of computer has arrived in the market and all software can be merged in it and facilitate us with almost all things which are possible through desktop, laptop and palmtop computers.

The future is the talk of innovating smaller sizes and shapes of computers which may contain everything as communication, business transactions and sharing heavy data in particular. The futuristic amazing and interesting thing will be that small shape of technology or computers which may easily accommodate in our eye, so it will be as Eye Blinking Business when humans will look to do a transaction, they will just be required to blink and the moment they will blink, the transaction will take place. We can imagine anything and any thing can happen. Thanks to the inventors, developers, technologists, teachers and researchers for bringing every time some thing very amazing.

III. Applications of Some Emerging Technological Activities

Following are some examples where emerging and different computer and IT related activities which are taking faster paces to modify the business methods.

- The companies such as General Motors, Sears and K-Mart also addressing the inefficiencies of inter-corporate document movement by using their own electronic (but proprietary) systems with their major trading partners. By the mid 1980's, K-Mart's system-

EPOS was being used by over 500 companies. Where was the problem? The problem lay in the fact that each system was specific to the company that in a proprietary sense had no standard except. A hypothetical company in the late 1960s doing business with GM, Sears and K-Mart therefore needed three different system interfaces to cope up with such complexity and they got solution because of systems providing common interfaces.

- The story with the grocery industry was different. One EDI historical example is Super Value, a large American grocery chain. Because they had to first deal with larger "within-the-company" EDI issues, they recognized early on the need for industry specific standards. They felt that a universal standard was impractical and unnecessary for the technology levels that were available and the extent of their needs. In the 1970's, several industries sponsored a shared EDI system that they usually turned over to a third party network. In some cases, the shared system was developed by the third party for the group of common companies or industry trade group. Examples of this early sharing include IBM IVANS, which the U.S. property and casualty insurance industry sponsored. Another was ORDERNET, sponsored by the pharmaceutical industry.

These industry trade group systems had the same disadvantage as the company proprietary EDI system: they were standard, but limited in scope, and unable to communicate with other trade group EDI systems. (ORDERNET, for example, could not communicate with the transportation carrier's EDI system.) In 1973, the TDCC decided to develop a set of standards for EDI between companies and to invent a so-called "living standard"-i.e: a standard that included standards on how to change the standards! This resulted in the first inter-industry EDI standard in 1975 covering air, motor, ocean, rail and some banking applications. What evolved included generic formats for general business ANSI X12, first published in 1981.

- European development of TRADACOMS, ODETTE and JEDI started around 1984. In 1985, work started on EDIFACT (EDI for Administration, Commerce & Transport), an international standard through the auspices of the United Nations.
- Federal Express executives say that in some areas, the company increased productivity 30 percent in the early 1980s when it launched its Digital Assisted Dispatch System. FedEx was able to more efficiently route pick up and deliveries, keeping couriers on the road. Coupled with the Super Tracker, a handheld device that communicates location, shipping, and other information about deliveries to customers and FedEx, the company was able to pick up and deliver packages in real time after 1986. One of the immediate benefits was that the wireless system eliminated the need to write down numerous addresses per day, saving time and money.
- Office Depot teamed with Aether Systems to develop a way to track the retailer's vehicle fleet and to capture customer signatures via a Palm- or Pocket PC-based handheld from Symbol Technologies. Office Depot cannot charge a customer until a signed bill is logged in the system. With the mobile device, the signature and bill are shipped to the Web and delivered, in real time, back to the customer. The system has rapidly improved Office Depot's cash flow.
- Networkcar is taking advantage of legacy technology and warehoused information and transporting them to a wireless world. The newly launched company sells a plug-in device that connects to computer diagnostic ports that are standard-issue in cars made after 1996. The device beams vital signs to a dealer, who can remotely diagnose or spot trouble. The advantage is that dealerships can achieve competitive advantage by maintaining a closer bond with their customers.
- Kemet Electronics is the nation's largest manufacturer of tantalum capacitors (small heat- and corrosive-resistant components that regulate electricity in devices such as radios and DVD players). The firm made a deal with IBM's pervasive computing division to deploy a wireless network that allows its sales force to access Lotus-based e-mail, calendar, scheduling, and other corporate information through PDAs, pagers, and cell phones. The system has increased the effectiveness and efficiency of Kemet's salespeople.
- California utility firm, Sempra Energy, is equipping its engineers with wearable computers. The engineers currently return to an office to enter information about heating, ventilation, and air conditioning units run by big users such as hotels. The wearable computers allow engineers to transmit and receive data and to make necessary equipment adjustments without leaving customer sites. The company says the devices will save a "ton of money."
- iMetrikus is an online medical treatment provider that is planning on taking their monitoring services mobile during 2001. The company allows doctors and patients online access to medical records. Patients can report any medical problems and update their health-care provider on what type and quantity of drugs they are taking. This is information that physicians routinely monitor. One iMetrikus client, age 62, checks his blood-sugar level as many as eight times per day, regularly uploading results onto the Web so his health-care provider can monitor his status. When he is on the road, which is often, he ducks into cyber cafés when possible or stops at public libraries to obtain some free Internet time. He complains about the trouble he has maintaining a virtual link to his physician when he is on the road – a link that grows more tenuous the deeper he goes into back roads. But he sees hope in wireless. As a Verizon cellular subscriber, he says he had a decent connection throughout most of his travels, although reception was spotty in parts of Canada.

The above examples have been collected from the available literature survey to support the concept of this research and to identify some emerging e-com technologies aspects in this fast paced changing technological era.

IV. Research Methodology

The research is an exploratory in nature which is based on literature survey, observation and some unstructured interviews to explore the nature and development of emerging e-com technologies in the developed and networked e-arena. Since the literature on e-com emerging technologies is not much available, therefore electronic communication, electronic business. Computer technologies and its development and strategic methods are mostly studied to reach and find the proper data of the topic.

V. Conclusion

Emerging Ecom Technologies are always at the pace of development because of the compatible development in other computer and IT related technologies. But emerging e-com technologies will always be on the top because of the major pertinence of business activities.

Such technologies are always a very interesting topic for IT specialists to innovate and adopt for the betterment of business. In this way the technology adoption of prevailing

trends and needs have become an essential part of today's top notch gurus of the organizations.

VI. Recommendations for Prospective Companies

- Companies must be fluent with the flexible and worth adopting emerging technologies in order to achieve an edge in various issues.
- Companies must adopt the changing patterns of emerging technologies with the faster flow of technological advancements in the areas of networking devices and databases in particular.
- Companies must cope up with an IT strategy of updating some major information layered processes which are very much pertinent with modern business and strategic analysis of technology decisions.
- Companies are required to watch changing business patterns through the study of consumer preferences and their trend towards technology regarding e-com and m-com positions
- Organizations of today's age are also required to have IT experts having enough knowledge of current IT systems as to avoid from any delay to the adoption of emerging e-com technologies

Strategic Application of E-Commerce for Customer Satisfaction: A Study with Small Businesses in Korea

Choong Y. Lee

Department of Management and Marketing, 1701 S. Broadway, Pittsburg State University, Pittsburg, KS 66762

Phone: 620-235-4588, Fax: 620-235-4513, E-mail: lee@pittstate.edu

Abstract: Recent development of information technology has brought dramatic increase of strategic use of information system in businesses all over the world. This paper will examine e-business application for customer satisfaction especially in Korean small and medium businesses to illustrate the major impact of information technology on small and medium sized firms in Korea, find out the roles of e-commerce within their supply chain systems in those small and medium-sized enterprises, and then, identify major barriers that prevent Korean small businesses from entering into e-commerce. Finally, this paper will propose an analytical framework for e-commerce penetration into small firms as a guideline of future applications in similar cases.

I. Introduction

There are few articles published on the applicability of e-business and its practices in small and medium-sized businesses. Most of research studies focus on the U.S. or Japanese businesses, with little thought being given to their applicability to small businesses in other less developed countries, such as Korea.

Small businesses are very different from large ones in many areas, such as management style, production processes, available capital, purchasing practices, inventory systems, and negotiating power. However, the nature of E-business suggests that application of e-business to small businesses may work well as it does for large ones. Some of the e-business elements and programs appear to be more compatible with small businesses. Some benefits from e-business may be relatively more significant to small firms. In addition, most small firms may be suitable for applying e-business because of its basic features.

E-business elements can be classified into two groups: (1) those that are independent of the size of firm, and (2) those that relate to the size of firm and may be more difficult for small businesses to employ. Actually, many small firms all over the world have already implemented lots of e-business elements in their daily operations of business.

Most of earlier researches focused mainly on the potential of e-commerce and its general impact on business activities, but few studied effective models of e-commerce for companies different in size, nature, country specific location, and other characteristics. This study, in order to construct a reasonable business model of e-commerce for small and medium sized companies, will focus on clarify the

characteristics of small and medium sized firms in a dynamic economy of Korea.

Earlier researches talked much about the potential of e-commerce and its general impact on business activities, but they did not mention to an effective model for small businesses. Because small businesses face much more obstacles than large companies do, the model that is fit and effective for small businesses may quite different from ones for large enterprises. This study, in order to construct a reasonable business model of e-commerce for small businesses, will focus on clarify the characteristics of small businesses in new digitalized economy, referring to some cases in Korea.

II. Existing e-Commerce Distribution Channel Models

Literature review shows that there are a number of categories of e-marketplace. It refers to the firm that operates an e-marketplace as the "intermediary", which may be a market participant, an independent third party of a multiform consortium. It further differentiates the market participant into a friendly participant, a hostile participant, a single-buyer participant, or a single-seller participant. It also classifies e-marketplaces into three categories: the e-broker model, the manufacturer model, and the auction model. It also looks into the success factors of an e-marketplace as strategic factors, technical factors, and functional factors. Strategies include first-to-market, brand establishment, customer focus, targeted marketing, outsourcing, and development of a customer or user community.

E-commerce is now another channel to market or sell to customers and consumers. Websites and emails are the two main e-commerce applications that are used together to promote and advance the selling process to closure. Grasping the knowledge and know-how of applying these powerful tools will help small businesses benefit from e-commerce.

There are several ways that websites can be used as a new sales channel for a business. They are websites sales models, sales support websites, e-catalogue and e-marketplace. Beside website, another powerful application – emails can be used for generating traffics to websites and supporting the sales process such as using periodic email, mailing list, mail attachment, and so on.

Enterprises may change their business model into one of above mentioned models of e-commerce distribution channels, based on the following four factors: (1) characteristics of the firm; (2) competitiveness and management

strategies of the firm; (3) influences of internal or external parties on the adoption decision process; (4) characteristics of new model adopted. For small businesses, the adoption of e-commerce model may depend on the fifth one, considered as the most important factor, the innovative attitude and knowledge about IT of the CEO.

III. Korean Small Businesses and their Distribution Systems

Small businesses have contributed significantly to the economic growth in many countries all over the world. They have accounted for a large share of total employment in those countries. However, in Korea the success of large corporations, so called "Chaebols" or conglomerates, has been well acknowledged. During the last three decades Korea achieved prominence in every industry, especially in manufacturing, based mainly on large corporations. They played a vital role in promoting rapid growth during Korea's economic transition. However, since the financial crisis in Asia in 1997, Korean large corporations have been blamed as a major source of the economic crisis in Korea. The national strategy of economic development based on large corporations had seemed to be successful until just before the crisis, but actually created lots of social and economic problems behind the success stories.

The new economic environment after the economic crisis in Korea makes it increasingly difficult for Korea to continue economic development based on large corporations. With a high unemployment rate due to the recent economic crisis, small businesses have received more attention than ever in Korea to provide steady economic growth with employment opportunity as the Korean government adopts strong policies and programs for the promotion and development of small businesses. Fortunately, Korea now understands that small businesses can exert a strong influence on its economy, particularly in the fast-changing and increasingly competitive global markets. Korea believes that small businesses can be a major engine of economic growth and technological progress in the future. Small businesses are often more fertile than larger firms in terms of innovation. The features of small businesses, such as flexibility, innovativeness, and problem-solving action orientation, are now being considered as vital for success in the Korean economy.

With the new government policy for promoting and supporting small businesses' application of information technology in their operations of daily businesses in Korea, Korean small businesses may be more encouraged to adopt e-commerce than small businesses in other advanced technology countries. However, one of the initiative factors that impulse small businesses into engaging e-commerce is the way to reach customers' needs and wants, and serve them in high level of satisfaction. This factor is now familiar with small businesses, especially in such a competitive market. Next parts will discover the distinctive characteristics of Korean distribution systems in order to clarify the

way that small businesses use to adopt e-commerce in Korea.

Like in Japan, most Korean businesses have multi-layered distribution systems which are quite complex and costly. It results in a supply chain in which most products change hands at least two or three times before reaching the retail outlet, consumer prices rise up and the productivity of retail sector is quite low. Korea has far fewer department stores and general merchandise super stores per capita than most of developed countries. Actually, it has much more other retailing stores per capita.

'Chaebol' refers to a unique form of Korean conglomerate. A chaebol is a grouping or family of affiliated companies that form a tight-knit alliance to work toward each other's mutual success. This system is also based on an intimate partnership between government and businesses. It can best be understood as the intricate web of relationships that links banks, manufacturers, suppliers, and distributors with the Korean government. Korean Chaebols operate globally and are integrated both vertically and horizontally.

IV. E-Commerce as a Competitive Tool for Korean Small Businesses

Even though the history of e-commerce in Korea is not long, more Korean businesses have tried e-commerce in their operations recently. The characteristics of Korean e-commerce is that the major companies who enter e-commerce market are mostly huge or big companies which have large capital and enormous potential human resources to be mobilized for both delivery and information technology. There may thus be a particularly strong rationale for governments to address the problems that impede small businesses from adopting and using electronic commerce. And this is also the reason why the adoption and use of e-commerce raise special issues for small businesses.

Unlike small firms in the US, which tend to operate independently, Korean small firms usually work for large corporations or engage in special relationships with Chaebols, such as subcontracting. To adopt e-commerce as a new high-tech marketplace these business alliances still facilitate small businesses to acquire various knowledge of new technologies.

It is obvious that although the potential of e-commerce is quite persuasive, however, number of companies, especially small businesses, which have engaged in e-marketplaces, is rather limited in Korea. Lack of access to bank loans and venture capital, shortage of skilled workers, and low level of business and technology skills are cited as reasons for the difficulties in adopting e-commerce of small businesses. Reasons are including the trustworthiness of on-line activities, lack of financial resource, and so on.

The emergence of intermediaries has contributed to the fast development of the B2B e-marketplaces in Korea. An intermediary usually is a company that provides the technical expertise to develop and/or set up a multi-buyer, multi-seller electronic market. An intermediary can also be a firm, which shares its TPN with other companies, and

thereby facilitates and controls a B2B solution. Kannan, Chang, and Whinston (2000) describe five ways that an intermediary can add value to the market: (1) researching buyer information needs, (2) acquiring relevant information about products from suppliers, (3) managing intellectual properties and copyright, (4) authenticating information suppliers, and (5) complementing, processing, and adding value to information products. They indicate that electronic communities are increasingly called upon to play the role of intermediaries. These e-communities consist of a critical mass of members whose needs are mainly commercial and who use the communities mainly for networking and building business relationships.

IV. 1 Buyer-Driven Catalog and Bidding Solutions

Buyer-driven solutions are systems that manage procurement by posting Request for Quotes (RFQ) and inviting bidding, or by allowing access to approved suppliers' products and services on the buyer's internal computer networks. Requisitioners of the buying company can make purchases from preferred suppliers on their company intranet, within limits of automatically enforced buying rules set by purchasing management.

Besides the generic benefits of e-procurement that were discussed in the Introduction, automated order-entry eliminates errors and accelerates the approval process. The buyer-driven system also supports an on-line catalog that limits the range of suppliers in order to avoid "maverick purchases," the purchase of items that are not from authorized suppliers or items that are not offered at the negotiated price. The solutions also help capture purchasing data within the buying company for further analysis and review. For the vendor or intermediary who provides the B2B solutions, it is important to serve as a consultant to help the buying client develop RFQs, qualify suppliers, or set up and manage bidding events.

IV. 2 Third-Party Catalog and Trading Exchange Solutions

A third-party B2B solution can include a collection of electronic catalogs of multiple suppliers that can be accessed and searched through one site (portal) by multiple buyers. It can also host auctions and bid-quote exchanges. Third-party sites are also called electronic market places, vertical portals, and electronic commerce hubs. Most of these third-party solutions focus on industry-specific vertical markets. These solutions offer a variety of applications for negotiation, bidding, payment, and display. Selected sellers and buyers can also form private networks based upon membership with a third-party solution.

To a buyer, third-party solutions offer an economical way of accessing the most up-to-date catalogs while reducing web-site hopping search of suppliers. They are especially popular for commodity products and fragmented markets with well-defined buyers and sellers such as steel, chemical, plastic resins, and plastic and paper packaging products. To the sellers, third party solutions create market

liquidity with a critical mass of buyers.

IV. 3 Seller-Driven Portals or Extranets

A seller-driven solution is a sellers' web site or extranet that provides electronic catalogs and allows on-line ordering. It is another type of the multi-lateral IOIS, a Broadcast Sales System developed by a seller. The benefits are quite general, such as the ability to check order status, confirm pricing, confirm payment or delivery, access technical support, register for seminars, and so on. These benefits can also be found in the buyer-driven and third-party solutions. In this type of system the seller has the highest control over product offering information and the trading process. This type of solution can often be developed more easily and quickly than the first two types of solutions because it can build upon pre-existing trading relationships. Though many larger supplier companies are developing their own seller-driven solutions, small businesses can use purchased solutions to bypass complex and expensive EDI requirements to level the playing field.

IV. 4 Value Chain Management Solutions

The above three types of B2B solutions are primarily designed for making the trade happen, that is, matching the buyer(s) with the sellers(s). Some degree of "integration" is possible between the IT systems of the trading partners, and they vary across the three types of solutions. However, value chain management (VCM) solutions focus on the integration of business processes between trading partners after the purchase contract is signed. These business processes tend to involve the exchange of more frequent information over the life of the contract. They usually include order processing, manufacturing planning and scheduling, and logistical planning.

Some VCM solutions specialize in enhancing customer relationship management. These solutions integrate the sales, marketing, and service functions of the seller firm to unify their transactions to support a customer order. Such capabilities improve both customer satisfaction and efficiency and control for the supplier/seller. On the other hand, other VCM solutions strive to integrate a manufacturing (a "buyer") firm with its suppliers. These kind of solutions serve as decision support systems to help the manufacturing company optimize its production and logistics network configuration and synchronize day-to-day interactions with its suppliers.

V. Conclusion

E-commerce may represent a considerable share of economic activity and improve the quality of distribution system in Korea in the near future. Small businesses now cannot further ignore the potential prospects that e-commerce is not an easy work, especially for small businesses, because of the existing of numerous barriers. Considering carefully determinants of its strategic use such as communication requirements, intensity of competition,

support and incentives may help small businesses select the right business model to perform.

To intensify effectiveness of e-marketplace for small businesses, this paper suggests integration of some possible e-commerce models that use website and email as practical e-commerce tools in tandem with finding experiences of Korean small businesses. Forming new business alliances will take positive effect for small businesses. These considerations lead to a research framework for analyzing e-commerce business models by small businesses.

In this paper, however, we are bounded in pointing out a new model of e-business that may be an effective way to accelerate small businesses performance. From this knowledge of e-marketplace and the practical performance within Korean small businesses, the further research may explore potential productivity of e-commerce, and then design an effective e-commerce model for small businesses.

(Due to space limitations references will be available upon request.)

Adopting Electronic Commerce as a Competitive Strategy in Malaysian Electronics SMI

Kamal Jit Singh, Barry Ritchie, Jun Xu
Graduate College of Management
Southern Cross University, Australia
Tweed Gold Coast campus, Brett Street, Tweed Heads
PO Box 42, Tweed Heads, NSW 2485, Australia
E-mail: jxu@scu.edu.au

Abstract: The research examines the required conditions and suitable model of Vertical Hub for Malaysian Electronics SMIs. The conditions required for a Vertical Hub were found in the Malaysian Electronics SMI sector and therefore, a Vertical Hub was supported. This research also reveals that the nature of transactions and business arrangements in the Malaysian Electronics SMI sector best suited the Exchange model of the Vertical Hub. The results of this study have both theoretical and practical implications.

Keywords: Competitive Strategy, Small and Medium Sized Industries Manufacturing, Electronic Commerce, Vertical Hub.

I. Introduction

The Malaysian Electronics Sector is the largest manufacturing sector and contributed 46.2% of Manufactured Exports in the period 1996 – 1997; amounting to RM 80,692.4 million [2]. The Small and Medium sized industries (SMIs) in this sector are facing stiff competition from lower cost countries, on top of the issue of restricted market access[12].

With the explosion of the Internet, Electronic Commerce has emerged as a mechanism that can offer a Competitive Strategy to organizations [1] [4] [14] [17]. Electronic Commerce is indelibly changing how businesses gain market access, present themselves and how they communicate with their buyers. Electronic Commerce, via a Vertical Hub, offers ubiquitous worldwide market access at a very low cost. It allows businesses to continue operating 24 hours a day, 7 days a week with remarkable ease [13]. Instantaneous access to information and acting on it immediately has now become a reality with the Vertical Hub, with new markets and channels being opened up that hold tremendous potential for all companies [14]. Electronic commerce provides Malaysian SMIs the opportunity to stay competitive at both locally and globally. The Malaysian government too has recognized the importance of Electronic Commerce and has setup the National Electronic Commerce Committee (NECC).

A Vertical Hub can provide Malaysian Electronics SMIs with numerous benefits, especially global market access at

an affordable cost, and enable them to compete effectively worldwide. In spite of the importance of the Electronics industry and the priority given to Electronic Commerce by the Malaysian Government, no research has been conducted to determine if a Vertical Hub could be setup for SMIs in this sector.

This Research therefore, is important, as it will help determine if a Vertical Hub can operate in the Malaysian Electronics SMI sector. If the conditions required for a Vertical Hub are present, this research will identify the market-making model of the Vertical Hub most suitable for the Malaysian Electronic SMI sector. Accordingly, the Research Questions are:

1. *Are the conditions that are necessary for a Vertical Hub present in the Malaysian Electronics SMI sector?*
2. *If these conditions are present, which market-making model of the Vertical Hub is best suited to Malaysian Electronics SMIs?*

This paper is organized as follows. The following section presents relevant background on vertical hub, the conditions and drivers required for a Vertical Hub, and different market-making models of Vertical Hub. The research method is then presented. Results of survey are presented and discussed in great depth. Finally, research limitations, future directions, and conclusions are presented.

II. Background

II.1 The Vertical Hub

Sometimes called a “Vortex”, “Butterfly Market” or “Net Market Maker” [14], the Vertical Hub is industry-focused and tends to foster a community for a particular industry. It attracts a more qualified, narrow and pre-selected audience, consisting of truly active buyers and vendors with high economic potential [16]. It uses the Virtual Community model as a strategy to bring buyers and vendors together; especially in markets where both have difficulty finding each other [18]. The Vertical Hub creates value by aggregating buyers and vendors, creating marketplace liquidity by mobilizing a critical mass of buyers and vendors, and thereby reducing transaction costs [9] [14]. In the mean time, Vertical Hub is cost-effective one-stop e-commerce solution and requires minimum upfront implementation costs [5] [11]. The Vertical Hub is a neutral community that offers independent and unbiased information [8]. Vertical

Hubs eliminate monopolies and force competitors to compete on the basis of value [7]. The anonymity, which is an important consideration for vendors, is also supported by Vertical Hubs.

There exist three different types of market-making models, namely Catalogue, Auction and Exchange, in Vertical Hubs. A Vertical Hub can operate in three different models – a Catalogue model, Exchange model or Auction model. The Catalogue model provides buyers with electronic catalogues of vendors participating in the hub and allows direct online comparisons. Some examples are: Echemicals (<http://www.e-chemicals.com>), Spplly Search (<http://www.supplysearch.com>), Hong Kong Trade Development Council (<http://www.tdc.org.hk>), E-steel (<http://www.esteel.com>), Fast-Net (<http://www.worldparts.com>), among many others. The Exchange Model offers a forum for both buyers and vendors to make bids and offers on a product or commodity. This format facilitates multi-lateral bids, offers and negotiations - allowing many buyers and vendors to simultaneously make bids and offers. Industry conditions and other characteristics determine which model is best suited to a particular industry. Some examples are ChemConnect (<http://www.chemconnect.com>), Altra Energy (<http://www.altrinet.com>), Bond Network (<http://www.bondnetwork.com>), IMX Exchange (<http://www.houstonstreet.com>), Paper Exchange (<http://www.paperexchange.com>), among many others. The Auction Model automates the process of allowing multiple parties to bid on an offer to sell or a request to buy. It improves efficiency, maximizes returns and is becoming increasingly popular due to the scale, reach and real-time attributes of the Internet [16]. It matches buyers and vendors in a secure trading environment and provides dynamic, real-time pricing [16]. A good example is freemarket.com.

A Vertical Hub is particularly desirable for SMIs, as it does not impose a heavy financial burden upon them. An SMI can enjoy all the benefits of Electronic Commerce and extensive market access, with either minimal upfront costs or only a commission payable for every successful transaction. No technical expertise is required as the Vertical Hub operator undertakes all implementation tasks. Discussions with industry experts and government officials have also revealed that virtually no research has been conducted in the area of Vertical Hubs for the Malaysian Electronics SMI sector. The researcher aims to extend the body of knowledge by filling this gap and determining if the conditions required for a Vertical Hub are present in the Malaysian Electronics SMI sector. If these conditions are present, this research will attempt to identify the market-making model most appropriate for this important sector.

II. 2 Industry and Market Conditions

For a Vertical Hub to be successful, certain conditions and drivers have to exist. These are a large and competitive industry consisting of technology savvy players, high pre-transaction costs resulting from market inefficiencies and difficult and costly market access. The Investment Analyst

company Bear Stearns, listed several market or industry characteristics that help define which industries will better support a Vertical Hub [3]. The more of these characteristics that exist, the more likely a Vertical Hub will be able to provide enough value to attract a community of buyers and vendors. These characteristics include:

- ❑ Large and Competitive Industry.
- ❑ Fragmented Supply Chain (High Company Search Costs).
- ❑ High Information Search Costs.
- ❑ High Product Comparison Costs.
- ❑ Difficult Market Access.
- ❑ Knowledgeable and Sophisticated Buyers.

An extensive literature review undertaken shows that the literature is silent on the Vertical Hubs for Electronics SMIs. Discussions with industry experts and government officials have also revealed that virtually no research has been conducted in the area of Vertical Hubs for the Malaysian Electronics SMI sector. The researcher aims to extend the body of knowledge by filling this gap by examining the following two research questions:

R1: Are the market conditions that are necessary for Vertical Hub present in the Malaysian Electronics SMI sector? Has the competition in the industry increased in the recent years?

R2: If the conditions required for a Vertical Hub are present, which market-making Model of the Vertical Hub is best suited to Malaysian Electronic SMIs?

III. Research Method/Design

Questionnaires were sent to the one hundred five Electronics SMIs, who are members of Small and Medium Industries Development Corporation (SEIDEC). The Ministry of International Trade and Industry has defined an SMI as (a) less the RM25 million turnover per year and (b) less than 150 full-time employees. No distinction was made between Malaysian and foreign-owned companies and discussions with senior ministry officials revealed that to the best of their knowledge, there were no foreign owned Electronics SMIs in Malaysia. The data was entered into the computer program “Statistical Package for Social Sciences” or “SPSS”.

IV. Results of Survey

Demographic Information

A total of 31 responses were received back from the population of 105. The bulk of Electronics SMIs in Malaysia were located in Selangor/KL, Penang and Johor. These three regions accounted for 82% of the Electronics SMIs in Malaysia. Discussions with MITI and SMIDEC officials had indicated that SMIs in these regions were more likely to respond to the questionnaire. Hence, it was anticipated that SMIs in the other regions would typically not respond to a

survey questionnaire. MITI and SMIDEC officials had confirmed that the Selangor / KL, Penang and Johor regions formed the hub of the Electronics industry in Malaysia.

Conditions Required for A Vertical Hub for Malaysian Electronics SMIs

Table-1 presents summary of analysis if conditions for a Vertical Hub. It can be seen from Table-1 that all the conditions required for a Vertical Hub for Malaysian Electronics SMIs were met, and Malaysian Electronics SMIs required the benefits that could be provided by the Vertical Hub.

Table-1 Results for Research Question 1

	Research Question 1 & Sub-Questions	Answer
1.	Are the market conditions that are necessary for the existence of a Vertical Hub present in the Malaysian Electronics SMI sector?	YES
a)	Has the competition in the industry increased in the recent years?	Yes
b)	Is competition expected to increase further with globalization?	Yes
c)	Is the Malaysian Electronic Industry large enough to support a Vertical Hub?	Yes
d)	Is the industry fragmented with no dominant seller or buyer?	Yes
e)	Are Vendor-search costs high?	Yes
f)	Do buyers and sellers have trouble finding each other?	Yes
g)	Do the SMIs have difficulty gaining market access?	Yes
h)	Are market gaining activities expensive?	Yes
i)	Are market gaining activities within the means of the SMIs?	No
j)	Is there unrecognised vendor or product differentiation along non-price dimensions such as product availability, delivery, support, etc?	Yes
k)	Are the products manufactured by the SMIs commodity-like and generic in nature?	Yes
l)	Are there rapid product introductions; i.e. products have short life cycles?	Yes
m)	Are there rapid inventory changes?	Yes
n)	Do these changes result in excess supply and inventory situations?	Yes
o)	Does excess inventory have to be disposed of anonymously?	No
p)	Are there rapid price changes?	Yes
q)	Do products have many features and characteristics, some of which are difficult to define or find?	Yes
r)	Do the products come in complex configurations?	Yes
t)	Is the transaction cost of the procurement process high?	Yes
w)	Are the buyers knowledgeable, sophisticated and aware of the power of the Internet and Electronic Commerce?	Yes

Suitable Market-making Models

The results in Table-2-5 suggest that the Exchange model was fully supported for Malaysian Electronics SMIs.

Table-2 Results for Research Question 2

	Research Question 2 and its Sub-Questions	Results
	Which market-making Model of the Vertical Hub is best suited to Malaysian Electronic SMIs?	Exchange Model
a)	Is the market fragmented with many buyers and sellers, with no one company having the lion's share?	Yes
b)	Are the demand and supply conditions predictable or volatile?	Volatile
c)	Are the products well defined?	Yes
d)	Are the products commodity-like?	No
e)	Are the products custom-designed?	Yes
f)	Are the products hard-to-find products?	No
g)	Is price volatility frequent?	Yes
h)	Are the prices fixed?	No
i)	Are prices negotiable based on supply and demand conditions?	Yes
j)	Is there often a need to dispose excess stock or inventory?	Yes
k)	Is there a need to regularly sell used or obsolete equipment?	Yes
l)	Do buyers only purchase from pre-qualified suppliers?	Yes
m)	Are pre-defined business arrangements with buyers necessary or can products be sold in a "spot market"?	Necessary
n)	Is the frequency of transaction with a buyer high, medium or low?	High
o)	Is there an anonymity requirement when surplus inventory is to be sold?	No
p)	Are the SMIs willing to pay set up costs or annual costs to implement Electronic Commerce?	Yes

Table-3 Exchange Model Conclusion

	Exchange Model
Fragmented Market	Yes
Volatile Industry Conditions	Yes
Business Arrangements	Pre-qualified
Standardized Products	Yes

Table-4 Catalogue Model Conclusion

	Catalogue Model
Fragmented Market	Yes
Differentiation Requirements	Yes
Run of Mill Purchases	No
Standardized Products	Yes

Table-5 Auction Model Conclusion

	Auction Model
Excess Supply Conditions	Yes
Absence of Pre-qualified Business Arrangements	No
Varied Product Types	Pre-qualified

V. Results Interpretation and Discussions

From the results in Table-1, it can be clearly seen that all the conditions necessary for a Vertical Hub are indeed present. While there exist required conditions for Vertical Hub for Malaysian Electronics Industry, the task of setting up a Vertical Hub for the Malaysian Electronics SMIs will be greatly assisted by the fact that there is awareness of the benefits that Electronics Commerce can bring and just as importantly, there is a willingness to use Electronic Commerce. Government organizations such as SMIDEC and others should be used as catalysts to involve SMIs in Electronic Commerce activities to improve their domestic, regional and international competitiveness. They should also be used to educate SMI on major Electronic Commerce trends such as Supply Chain Management and other differentiation models that are being deployed by organizations in the western world. There is a clear need for the Government to have a specific policy on Electronic Commerce with respect with SMIs and to incorporate Vertical Hubs in this policy. The results of the study (Table-2, 3, 4,5) clearly show that the only market-making model supported by the conditions in the Malaysian Electronics SMI sector is the Exchange model.

A Vertical Hub and in particular the Exchange Model, provides easier and lower-cost access to buyers that otherwise, may have been difficult or expensive for vendors to reach. Government organizations such as SMIDEC and others should be used as catalysts to involve SMIs in Electronic Commerce activities to improve their domestic, regional and international competitiveness. They should also be used to educate SMI on major Electronic Commerce trends such as Supply Chain Management and other differentiation models that are being deployed by organizations in the western world. There is a clear need for the Government to have a specific policy on Electronic Commerce with respect with SMIs and to incorporate Vertical Hubs in this policy. The task of setting up a Vertical Hub for the Malaysian Electronics SMIs will be greatly assisted by the fact that there is awareness of the benefits that Electronics Commerce can bring and just as importantly, there is a willingness to use Electronic Commerce.

VI. Conclusion and Future Research Directions

This research has shown that the conditions necessary for the establishment of a Vertical Hub exist in the Malaysian Electronics SMIs. The findings of this research have shown

that shown that the Exchange model is the most appropriate model of Vertical Hub for Malaysian Electronics SMI sector. A Vertical Hub will greatly enhance domestic market access. Globally, there are already several Vertical Hubs for the Electronics industry. For the Malaysian Electronics Vertical Hub to be successful, buyers that participate in the other Vertical Hubs have to be attracted to participate. Unless there is participation from global buyers, a Vertical Hub set up for the Malaysian Electronics SMIs will provide only improved domestic access.

Further research is required to ascertain how these global buyers can be attracted to participate in the Malaysian Electronics Vertical Hub. Further research is also required to determine how linkages can be formed with the existing Vertical Hubs to improve international market access using the Malaysian Electronics Vertical Hub. Further research is also required to determine whether a low-touch or high-touch hub is more appropriate for Malaysian Electronics SMIs.

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Value-at-Risk for e-business Project and Portfolio Appraisal and Risk Management

Stefan Koch

Institute for Information Business
Department of IS and Operations
Vienna University of Economics and BA
Augasse 2-6, A-1090 Vienna, AUSTRIA
EMAIL: stefan.koch@wu-wien.ac.at

Abstract: This paper makes the case for adopting a risk measure from the finance sector for the evaluation of e-Business projects and portfolios. The proposed value-at-risk method constitutes a well-tested approach in high-risk environments, especially banking, and reports the expected maximum loss (or worst loss) over a target horizon within a given confidence interval. Value-at-risk is computed using either an analytical, parametric approach, or resorting to simulation, either based on historical samples or Monte Carlo methods. In this paper, both the use for evaluating single e-Business projects and also associated portfolios is discussed. Small examples are given and assessed to illustrate both applications. The main advantages of using value-at-risk measures are that they are methodologically consistent with modern IS evaluation approaches like real options, that they offer possibilities for management and assessment of project portfolios, and that the results are easy to interpret.

Keywords: Technology Management, Investment Analysis, Value-at-Risk, Risk Management.

I. Introduction

In the last years, the evaluation of IS/IT and especially e-Business projects has been the center of much debate. One of the reasons for this debate has been the e-commerce and Internet bubble which exploded a few years ago. Naturally, investments into new technology, especially e-Business, and respective start-ups need to be carefully analysed, especially in this new environment. Associated with this trend, risk management has become a center of attention, both within an organisation performing one or multiple projects or for an investment in a portfolio of start-ups [19] [5] [10].

Regarding valuation of IS/IT projects, the real options approach [27] gained prominence in the extant literature in the last years [21] [6] [25]. This approach is based on option theory from finance, and tries to incorporate the management's flexibility into decision making. Especially several possible options like abandonment, or expansion (growth) options offered by pilot projects are of interest in IS/IT projects. In the literature, several applications for real options have been described, including software growth options used in evaluating software platform decisions [25] [26], or investment timing in the development of point-of-

sale (POS) debit services [6] [7]. In the last years, the focus has shifted from evaluating one (or more) known options embedded in a project towards active management and planning of options in IS/IT investments for managing and controlling risks [5].

Extending the approach of using analogies with finance, this paper argues for adopting a value-at-risk approach in evaluating e-Business projects and for improving risk management. The main advantages of using value-at-risk measures are that they are methodologically consistent with modern IS/IT evaluation approaches like real options, constitute a tested and used approach in high-risk environments, especially banking, that they offer possibilities for management and assessment of project portfolios including existing dependencies and diversification effects, and that the results are easy to interpret.

The structure of this paper is as follows: First, an introduction to value-at-risk will be given, highlighting both shortly its history in the finance sector and the main points of the computation itself. Then, the application for evaluating a single e-Business project will be discussed, afterwards detailing the use for project portfolio risk management. In both cases, small illustrative examples are given and discussed.

II. Introduction to Value-at-Risk

II.1 History and Applications

The history of value-at-risk is deeply interwoven with the finance sector and especially banking. In the strive for financial stability, a first landmark decision was the 1988 Basle accord by the central banks from the G-10 countries, which defined a minimum standard of capital requirements for commercial banks, using a percentage of risk-weighted assets [2]. As this first approach has faced criticism, including that neither portfolio risk, nor netting, nor market risk have been accounted for, modifications have become necessary. In 1993, one of the most important documents, the Group of Thirty's report on derivatives was published, explicitly endorsing value-at-risk for measuring market risk [11]. This concept was then popularized by the RiskMetrics system originally developed by J.P. Morgan [16]. The Basle accord, after an amendment for market risk in 1996 [3], in its latest version from 2001 now also 'strongly recommends' that banks disclose their value-at-risk [4]. The U.S. Securities and Exchange Commission (SEC) also now requires all large U.S. publicly traded corporations to report

quantitative data on market risk exposure in their report to the SEC, listing value-at-risk as one of three possible methods for doing so [22] [12] [13]. Recently, it has been empirically shown that value-at-risk disclosures of banks are significantly related to future market risk [13].

In the last years, applications of value-at-risk measures have started to begin in areas other than finance, including inventory management [15], the purchasing process [20] or even real estate investment [14].

II. 2 Computing Value-at-Risk

While several definitions for value-at-risk can be formulated, it basically indicates the greatest potential loss of a position or a portfolio, which can be verified with a certain probability, within a defined time horizon [24] [8]. Or, as Jorion puts it, value-at-risk summarizes the expected maximum loss (or worst loss) over a target horizon within a given confidence interval [12].

These definitions already hint at several important characteristics of value-at-risk: It can be computed both for a single position or for a diversified portfolio, and it has some discretionary power, in that both the holding period (time horizon, target horizon) and the confidence interval need to be defined by the user. The holding period should be set with the type of portfolio considered taken into account, setting a horizon corresponding to the period necessary for orderly liquidation [12]. For example, a bank computing their value-at-risk for a portfolio of highly liquid currencies might even resort to using one day as holding period. The confidence interval chosen should necessarily either reflect regulatory imperatives, risk attitude, or depend on characteristics of the underlying distribution.

Having set both holding period and confidence interval, value-at-risk is computed by estimating the probability distribution of gains and losses of the considered position or portfolio over the time horizon, and then finding the point at which the probability of incurring greater losses corresponds to the set confidence interval (in fact to one minus the confidence interval). Therefore, value-at-risk reports a single, easy to interpret figure: The loss of money that is not exceeded at the probability of the confidence interval over the defined time horizon. In the most general form, value-at-risk can therefore be derived from the distribution of the future portfolio value $f(w)$, finding for a given confidence interval c the worst possible realization W^* such that:

$$c = \int_{W^*}^{\infty} f_{\tau}(w) dw. \quad (1)$$

The value-at-risk can be either reported relative to the mean (the expected portfolio value) or as absolute loss relative to zero.

For computing value-at-risk in practice, three approaches are proposed, each with specific strengths and weaknesses. These are the parametric, or analytical or variance-covariance approach, historical and Monte Carlo simulation [18] [23]. Sometimes the latter two are grouped together under the name of simulation or full valuation methods [8]

[12] [24]. While historical simulation necessitates large historical samples (and attendant assumption of stable volatilities), Monte Carlo simulation naturally can become complex and costly in computer resources for large real-world portfolios (although in the last years several ways were proposed to increase the speed of Monte Carlo simulations [18]). Most often used, due to being the first version having been developed, ease of implementation and conceptual fit with modern portfolio theory, is the parametric approach.

The main hypothesis behind the parametric approach is that the future portfolio values (and hence returns) follow a parametric distribution, the most common assumption is that they follow a normal distribution. Therefore, value-at-risk can be derived directly from portfolio standard deviation σ (using a multiplicative factor α dependent on the chosen confidence level). For a single position with initial investment W_0 , the value-at-risk below the mean then is given by:

$$VAR(mean) = W_0 \alpha \sigma \sqrt{\Delta t}. \quad (2)$$

For a portfolio of assets, as the return of each single asset is assumed to be normally distributed, the portfolio return as a linear combination of normal variables is necessarily normally distributed as well. Due to the diversifying effects of a portfolio, the value-at-risk of a portfolio is not the sum of the value-at-risks of all single positions, but needs to incorporate the respective covariance matrix. The delta-normal method defines relations between financial positions and underlying, primitive risk factors which again are normally distributed. For an instrument whose value depends on a single underlying risk factor S , first the portfolio value at the initial point is computed, together with the first partial derivative Δ_0 with respect to the underlying risk factor S , the sensitivity of value to changes in the risk factor at the current position, termed delta for derivatives. The potential loss in value dV is then computed as

$$dV = \Delta_0 \times dS, \quad (3)$$

using the potential change ds in the underlying risk factor. If the distribution is normal, the value-at-risk can be derived from the product of the exposure and the value-at-risk of the underlying variable:

$$VAR = |\Delta_0| \times VAR_S = |\Delta_0| \times (\alpha \sigma S_0). \quad (4)$$

For a portfolio, the delta-normal method uses a set of primitive risk factors, onto which the positions are mapped using the respective delta-positions denoted by vector \mathcal{Z} , and the covariance matrix Σ between risk factors over the target horizon together with the specified confidence level to

compute the portfolio value-at-risk:

$$VAR = \alpha \sqrt{\chi' \Sigma \chi}. \quad (5)$$

Especially with derivatives like options, due to their non-linear nature, including the second derivative using delta-gamma approximation is recommended to increase the fit. For a more thorough treatment of value-at-risk than is possible here, the works of Jorion [12], Best [8], Pearson [17] and Allen, Boudoukh and Saunders [1] are useful starting points.

III. Value-at-Risk for e-Business Project Evaluation

III.1 Introduction

The first and most important question is whether the value-at-risk can in general be determined for an e-Business project. Following the most generic terms and definition of value-at-risk, it can naturally be derived. Every e-Business project entails a certain amount of uncertainty, therefore a probability distribution of gains and losses over a set time horizon naturally exists. Necessarily, any arbitrary confidence level can thus be set, and the cutoff point in the probability distribution specifying the loss not exceeded with corresponding probability can be determined, thus giving the value-at-risk.

Before specific problems of computation, uses and advantages and disadvantages are addressed, specification of both confidence level and time horizon in the context of e-Business projects need to be discussed. While the confidence level can be determined quite analogous with classic value-at-risk, e.g. using 95% or 99%, but keeping in mind possible characteristics of the underlying distribution, the time horizon needs to be more carefully evaluated. Depending on the reason for project evaluation, the holding period should be set accordingly. In finance, the holding period normally corresponds to the time period necessary for orderly liquidation of the asset considered. For e-Business projects, liquidation is most often available by stopping a project, which is normally possible at short notice or immediately. Due to the fact that e-Business projects (normally) are not traded assets, this would mean exercising an abandonment real option, forfeiting any further benefits but also costs. While this analogy would lead to assume very short holding periods, the volatility of an e-Business project's gains and losses over short periods of time will be small. Therefore longer holding periods should be considered in the context of e-Business projects. If a single project is considered, the holding period could even be set to the assumed project length. For application within a larger organization performing several concurrent projects, evaluation of a start-up portfolio or similar as will be detailed in the next section, the holding period should necessarily be reduced to be in the area of one or several months, maybe a quarter.

In the evaluation of single projects, value-at-risk measures can be computed both at the beginning (normally using project length as holding period), and also during the project for continuous monitoring. At the point of an investment decision at project start, value-at-risk measures allow for easy to understand, monetary quantification of associated risks, and therefore offer a good complement for other measures like net present value. On the downside, computing value-at-risk is either trivial and therefore offers little additional information, necessitates strong assumptions like normal distributions or gets complex if Monte Carlo simulation is employed. Using historical simulation will be mostly problematic due to missing large historical samples.

III.2 Examples

For illustrative purposes, a first simple e-Business project will be considered. This project will, over its projected length of one year, necessitate costs of about 100 monetary units (MU), and is projected to generate positive cash flows of 140 MU with probability $p_1 = 0.4$, of 120 MU with probability $p_2 = 0.2$, of 100 MU with probability $p_3 = 0.2$, of 80 MU with probability $p_4 = 0.1$ and of 0 MU with probability $p_5 = 0.1$. No embedded options are considered at this stage, and temporal aspects, i.e. discount rates, are neglected.

The resulting probability distribution for project value after one year therefore is discrete and is easily constructed. Setting a confidence level of 95% allows to easily determine the cutoff point in this distribution, leading to an absolute value-at-risk below zero of 100 MU, or a relative value-at-risk to the mean $E(P) = 8$ of 108 MU. While this seems straightforward and trivial in this simple case, stating these figures already offers additional information regarding risk for the project, and might serve as an important complement to reporting only mean project value, or a measure like discounted cash flows.

Next, we will consider the case of a software growth option, implementing a web-based e-commerce system, embedded into a platform change from SAP R/2 to SAP R/3. This option and its data are taken from a paper by Taudes, Feurstein and Mild [26]. They give the spot price S_0 with 880,000 MU and a volatility $\sigma = 0.8$. The valuation of this american call option using the Black-Scholes formula [9] gives a value of 514,000 MU, with a delta (exposure) of 0.7756. Using delta-normal valuation and 95% confidence level (which corresponds to $\alpha = 1.645$) in equation (4) results in a value-at-risk of 898,207 MU.

IV. Value-at-Risk for e-Business Project Portfolios and Risk Management

IV.1 Introduction

There are numerous examples for when an e-Business project

portfolio needs to be evaluated regarding the contained risks. These include the classic case of a large software developing organisation that performs several concurrent projects. In that case, overall risk assessment is of high interest, especially if a diversification effect is possibly in place or is strived for. The next application is to evaluate a portfolio of e-Business startups, as held or being built by an investor. While this is more akin to the use of classical instruments from finance, start-ups in this area can also be seen as e-Business projects, as they usually have a very focused area of business.

The last, and maybe the most often occurring possibility is a portfolio of an e-Business project with several embedded options. In that case, an assessment of the underlying risk factors is necessary. If only a portfolio of a project and an embedded option for example to defer the investment, priced as an American call on the gross present value of the completed project [27] is considered, there is only one underlying risk factor, project value, which eliminates any diversification effects. This would reduce the associated covariance matrix Σ in the delta-normal method to a scalar, the risk factor's variance σ , with a vector χ of two delta-positions describing the exposure of both positions, project and option, to this risk factor (see also equation 5). On the other hand, options on a different underlying asset embedded in a project could maybe depend on one or more other primitive risk factors. Therefore, a portfolio composed of one project and one or more options is to be considered, the risk of which should necessarily be assessed. In this case, diversification might be present, and needs to be included in the computation of the portfolio value-at-risk. In the second example given in the last section, a growth option for implementing a web-based e-commerce system was evaluated according to its value-at-risk on its own. As this option was embedded into a platform change from SAP R/2 to SAP R/3 together with four others, with these option values leading to a positive expanded (strategic) net present value of the platform change [26], the whole portfolio of platform project and real options needs to be evaluated together. Simply evaluating each component separately and summing the resulting value-at-risks would negate any benefits from diversification, and give a result which accordingly is too high. While two of the options implement EDI-based solutions, the others including the e-commerce system and the main platform project would be exposed and mapped to different risk factors.

IV. 2 Example

For illustration, we will now expand on our treatment of the option as presented in the last section, complemented with the main platform project. Again, data are taken from the paper by Taudes, Feurstein and Mild [26], although a volatility for the main project of $\sigma_{project} = 0.2$ is newly introduced. Data for the web-based e-commerce system remain unchanged from last section. Furthermore, we presume the presence of two risk factors, with each position

exposed to one of them, the option according to delta-normal method with delta 0.7756 as in the last section, the platform project with its full value at -416,500 MU. Lastly, a correlation of 0.3 is assumed between the risk factors. Using equation (5) at confidence level 95% corresponding to $\alpha = 1.645$ gives

$$\begin{aligned} VAR_{div} &= \\ &= 1.645 \sqrt{\begin{bmatrix} -416,500 & 0.7756 \times 880,000 \end{bmatrix} \begin{bmatrix} 0.2^2 & 0.3^2 \\ 0.3^2 & 0.8^2 \end{bmatrix} \begin{bmatrix} -416,500 \\ 0.7756 \times 880,000 \end{bmatrix}} \quad (6) \\ &= 828,907. \end{aligned}$$

The portfolio value-at-risk therefore is 828,907 MU, which due to diversification effects is smaller than the sum of individual value-at-risks (the undiversified value-at-risk). This sum can easily be computed for a comparison by applying equation (4) for the project and adding the result for the option from the last section (also derived from using equation 4) as

$$\begin{aligned} VAR_{undiv} &= VAR_{project} + VAR_{option} \\ &= (1.645 \times 0.2 \times |-416,500|) + 898,207 \\ &= 137,028 + 898,207 = 1,035,235. \end{aligned} \quad (7)$$

The resulting difference of 206,328 MU therefore represents the effects of diversification present in the portfolio due to the fact that both positions are mapped to different primitive risk factors, which are not highly correlated.

IV. 3 Risk Management

Especially the aspects of value-at-risk described in this section, i.e. the possibility to compute and value any effects from diversification on the risk of portfolios, is an important asset of this method. In analysing portfolio value-at-risk, the change in value-at-risk due to addition of a new position can be computed, termed the incremental value-at-risk, as well as the component value-at-risk, giving the reduction of the portfolio value-at-risk resulting from removal of a position. Due to diversification, both measures would in most cases be different than the individual value-at-risk of the position. This can also easily be seen from the above results. These possibilities allow for an in-depth analysis of different components in a portfolio, or could even be used as a constraint for portfolio optimization [28] [29].

An important point to consider when using value-at-risk to evaluate an e-Business project and/or portfolio with or without options is which primitive risk factors to choose, and especially how to map the different positions to them, if the delta-normal method is to be applied. A survey of the extant literature yields a list of several risk factors commonly associated with IS/IT projects, including the main

groups of technological and organizational risk [26]. The most complete taxonomy currently to be found is by Benaroch [5], who distinguishes between the group of firm-specific risks, including monetary, project, functionality and organizational risk, of competitive risks and of market risks including environmental, systemic and technological risk. He further argues for real option analysis to assist in risk management by deliberately embedding suitable options to address the various risks and thus optimally configure the investment during the different stages in the investment lifecycle [5]. This line of research therefore shows distinctive relationship with the value-at-risk approach argued for in this paper, with value-at-risk offering a way of quantifying any risk reduction afforded by embedding certain options into the investment portfolio.

V. Conclusion

This paper has argued for adopting the value-at-risk approach in the evaluation of single e-Business projects and also of portfolios constructed from these projects and/or related real options. As has been detailed, value-at-risk is a common and accepted measure in the finance sector, especially in banking, and offers several advantages also for the area of e-Business projects and portfolios. While there are several approaches for computing value-at-risk, not all of these might be suitable for e-Business projects and portfolios, as large historical samples will in nearly all cases be absent. On the other hand, both Monte Carlo simulation and an parametric or analytical approach seem feasible, with the former being computationally more taxing.

Using small, illustrative examples, we have shown that value-at-risk can indeed offer additional information in evaluating single e-Business projects or real options on such projects, offering an easy to interpret way of quantifying and comparing associated risks, and especially in evaluating e-Business project and/or option portfolios, as this method explicitly accounts for diversification effects. In addition, the changes in risk exposure due to changes in the portfolio, both from eliminating and adding new positions, can easily be determined, making value-at-risk a useful tool for risk management and assesment, therefore ideally complementing and extending the real options approach.

If value-at-risk is indeed adopted, many further enhancements are possible, including the introduction of a risk adjusted performance evaluation of business units or project managers. Their performance is in this case adjusted for the risk taken, by using for example profit over value-at-risk for assessment [12] [8]. Naturally, many further issues still need to be investigated in the context of value-at-risk for e-Business projects and portfolios, especially the definition of primitive risk factors, the mapping of different positions to these and some others. Nevertheless, adopting value-at-risk might provide important additional information for decision makers in the area of e-Business, and might constitute a necessary step towards implementing e-Business risk management.

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Application Frameworks Technology in Theory and Practice

Wusheng Zhang¹ and Mik Kim²
Centre for International Corporate Governance Research¹
Centre for Hospitality and Tourism Research²
Victoria University, Melbourne, Australia
Email: wusheng.zhang@vu.edu.au mik.kim@vu.edu.au

Abstract: Application frameworks is a technology concerning with building and implementing reusable software artefacts. Most current application frameworks are object-oriented and often domain specific. Advocates of application frameworks claim that the technology is one of the most promising technologies supporting large-scale reuse, increasing the productivity and quality, and reducing the cost of software development. Many of them project that the next decade would be the major challenge for the development and deployment of the technology. The objective of this study is to investigate the theory and practice of application frameworks and to determine if it has made a difference in systems development. The study indicates that the technology is still immature and not yet to be another silver bullet but potential is imminent.

I. Introduction

Software development markets expect the developers or development companies to deliver quality products at an affordable price within a required time frame. The developers and management alike are looking for technologies that can be used to increase the productivity and quality of the software products. Matured engineering disciplines, such as automobile design, have proven that reuse is the best way to increase the quality and productivity of products. However, despite the effort of last decades-long research the result of software reuse is still limited in code or class reuse (also known as small-scale), and developers are still 'reinventing the wheels'. Application frameworks are a technology anchored in this situation to promote reuse in terms of not only the code or class but also the module and architecture (also known as large-scale) of the reusable software artefacts to increase software productivity and quality.

II. Application Framework Technology

The Microsoft Encarta English Dictionary 2001 defines framework as "a structure of connected horizontal and vertical bars with spaces between them, especially one that forms the skeleton of another structure; a set of ideas, principles, agreements, or rules that provides the basis or the

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outline for something that is more fully developed at a later stage." The common sense of the word of framework appears to be "the skeleton of another structure", which has been well adopted into the context of modern information systems development. Booch, Rumbaugh and Jacobson [4] define a framework as "an architectural pattern that provides an extensible template for an application within a domain". In this context a framework is essentially a design skeleton that allows systems developers to create part of a system in the first place, and add design details when necessary. Johnson [23] states that the definitions of frameworks vary, but the one used most is that "a framework is a reusable design of all or part of a system that is represented by a set of abstract classes and the way their instances interact". Another common definition is "a framework is the skeleton of an application that can be customized by an application developer". The former concerns the structure of a framework while the latter describes the purpose of the framework. Lewis et al. [24] argues that a framework is more than a class hierarchy. Fayad [14] claims that a framework is a reusable, 'semi-complete' application that can be specialised to produce custom applications. Zamir [34] defines "an object-oriented framework is the reusable design of a system or subsystem implemented through a collection of concrete and abstract class and their collaborations. The concrete classes provide the reusable components, while the design provides the context in which they are used." The concepts of frameworks and application frameworks are often used interchangeably in the context of systems development. The definitions by different researchers or authors vary, some of them are more abstract and concerning more on the analysis and design phase, and others are more interested in design and development phase. The different emphases does not conflict each other but rather enrich and enlighten the further research issues related to the field of application frameworks technology.

Application frameworks can be domain independent such as graphical user interface (GUI) framework or domain dependent/specific such as CIM framework. They can also be classified according to the scope, reuse perspective, the control aspect and the development process of application frameworks. According to the scope of application frameworks, Fayad [17] proposes to classify it into three categories namely as system infrastructure frameworks i.e.

graphical user interface (GUI) and Microsoft Foundation Class (MFC); Middleware integration frameworks i.e. BEST and JAWS; Enterprise application frameworks i.e. SEMATECH CIM, OSEEFA and PRM. He claims [15] that application frameworks are generally domain specific applications such as computer-integrated manufacturing frameworks, distributed systems, networking and telecommunications, or multimedia collaborative work environment. From the perspective of the reuse application frameworks can be classified into whitebox and blackbox frameworks [33] [17]. Fayad [17] also proposes a greybox approach, which is a mix between the whitebox and blackbox frameworks. A whitebox application framework is a framework customised by subclassing existing framework classes and providing concrete implementations. To implement whitebox frameworks application developers use more inheritance and polymorphism. Application specific functionality is expressed by inheritance and new implementations. Implementation inheritance tends to require knowledge of the superclasses' implementations. In the last few years application frameworks researchers are more interested to develop blackbox application frameworks, which rely more on composition rather than inheritance. In blackbox frameworks approach, the extendability of the framework is achieved by defining interface for components that can be plugged into the framework using composition. Object composition is based on forwarding rather than delegation, merely relies on the interfaces of the involved objects. In a blackbox framework [17], an application developer selects from the set of subclasses provided by the framework as blackbox components and binds it to the hot spot (plug in point). Thus, the developer may create an application without programming, merely by selecting, configuring, and parameterizing framework components. From the perspective of taking control application frameworks can also be classified as callable framework and calling framework [17]. A callable framework allows the application to retain the thread of control and provides services when the application calls the frameworks. A calling framework provides a control loop that calls application-provided code at appropriate times. From a development process perspective application frameworks can be divided into analysis frameworks, design frameworks, and implementation frameworks. Analysis frameworks typically focus on analysis level constructs, without making any commitment. They are typically the product of domain analysis. Most of the current application frameworks are either a design framework or an implementation framework.

Most of the application frameworks are domain specific such as a financial application framework or a manufacturing framework. An application framework domain is a set of rules and roles and their semantic models codified in the framework itself. It provides a generic incomplete solution to a set of similar problems within an application domain. Fayad [17] states that an application framework embodies generalised expertise in the domain based on analysis and synthesis of a wide range of specific

solutions. He argues that analysis and synthesis of a wide range of specific solutions will help to understand a design of the proposed application framework. It is proven that the research community has more understanding in some domains such as financial, manufacturing, communication and networks and social welfare than others [13][17].

The development of application frameworks research is related to the development of objects technology although there is no evidence of that the technology is exclusive to objects technology. However, the majority of the researchers in that area of application frameworks and most of the current application frameworks are object-oriented. Iterative and incremental development approaches have been the main development methodology supporting the development of application frameworks [15]. Application frameworks design can be bottom-up and pattern driven or top-down and target driven [17][31][33]. The bottom-up design works well where an application framework domain is already well understood. Starting from proven patterns and working one's way up has the advantage of avoiding idiosyncratic solutions in the small, problematic solutions that should be replaced by application of an established pattern. Top-down and target driven approach is preferable where an application framework domain has not yet been sufficiently explored but where the target domain to be served by the framework is well understood.

Research [15][17][24][29] has indicated that building application frameworks is hard and implementing application frameworks is as hard as building application frameworks. According to a survey [17] the minimum time spent in developing an application framework was half of person month and the maximum time to develop an application framework was 1000 person months. The average time to develop an application framework was about 21 person months. An application framework conventionally consists of the core classes of an application, and one has to understand the basic architecture of a particular application type to be able to specialise the framework [29]. Using an application framework may simplify application developers' life since a framework provides generic solutions for a particular application domain. However, the average learning time is a big factor in establishing the cost of final application. The application developers have to understand what solutions the framework provides, and to comply with the rules imposed by the framework.

Chen [8] promotes that reusable components and frameworks must be accumulated in a standardised format. Most of the researchers agree that the classification structure of an application framework must be appropriate and manageable. Application developers will have difficulties with understanding the framework if the structure of the framework is not clear and standardised. Currently literatures indicate that application frameworks still lack of standards. Fayad [15] [16] [17] states that building and implementing application frameworks still need more methodological support.

There are a few domain specific application

frameworks have been used in the industry, for example, San Francisco framework, SEFA framework and SEMATECH CIM framework. The San Francisco framework is an application framework based on Java technology to develop business applications. It provides both a software solution for implementing business applications and a collection of concepts or strategies to develop business applications. According to the white paper from IBM [22] that the San Francisco framework is motivated from over 130 software vendors. The project was started when several software vendors asked IBM to help modernising their application products but there were several barriers preventing them from being able to update their applications. IBM claims that the San Francisco framework can solve 70% of the business related problems and leave 30% to the applications developers. IBM also claims that the framework makes it easier to move to object-oriented technology because developers use well-tested services instead of building their own. The project helps to solve these problems by offering developers Business Process Components. It is designed as a framework that provides an object oriented infrastructure, and a consistent application programming model and some default business logic. The San Francisco Framework is designed to make many types of extensions easy for application developers, allows overriding the default business logic in supplied methods, and adds additional attributes to existing classes. The San Francisco Framework offers three layers of functionality such as business processes, business objects, and foundation classes, each of which may be used and extended by developers to build their applications. OSEFA (German: Objektorientierter Softwarebaukasten für Fertigungsanlagen) is a blackbox application framework. It contains models of technical components as well as models of conceptual task-related components, and of application logic components. The prototype of the project was built in 1993 and the full version of the framework became operational in early 1996. The architecture of OSEFA has five layers, a machine and communication specific layer, a standardised machine layer, a task specific layer, a part processing layer, and a machine order layer [31]. He claims that through the project of OSEFA they have demonstrated how to use design patterns to create a sophisticated class structure from a simple result of object-oriented analysis. OSEFA [32] discloses the cost issues and states that developing a blackbox application framework takes around two to three times as much effort as developing a fixed application from the domain. This number may vary with the domain and includes the costs of analysing the domain and sufficiently generalising the class structure, but not the cost to acquire knowledge of framework structure and design. OSEFA claims that developing an application framework is worth the effort. The investment will pay off after the creation of about the third application from the framework. OSEFA experience indicates that another advantage of using application frameworks approach is the short time span required for the creation of a customer-specific or product-

specific application from a framework. SEMATECH is the semiconductor manufacturing technology consortium, whose member companies are AMD, Digital, Hewlett-Packard, IBM, Intel, Lucent, Motorola, National Semiconductor, Rockwell, and Texas Instruments. CIM is an instance of callable framework and component is the smallest unit of functionality that can be added, deleted, enabled or disabled in a CIM framework-compliant application. The goals of CIM include flexibility, interoperability, substitutability, integration and reuse [17]. Standardisation of CIM framework was started by the Semiconductor Materials and Equipment International (SEMI) organisation in early 1997. In 1998 the SEEMI Global CIM Framework Task Force initiated two successful letter ballots, resulting in adoption of the first two parts of the CIM framework standard. The first part, the Provisional Specification for CIM framework Domain Architecture establishes the architecture foundation for the component structure and partitioning, and identifies the responsibilities of each major component of the framework. The second part is a document- Guide for CIM Framework Technical Architecture, defines required infrastructure technologies needed to support framework and their customers must be prepared to make [17]. The experience from CIM [17] indicates that implementation experience is essential; frameworks increases initial cost; infrastructure coupling is hard to avoid; frameworks overlap; technology is immature and standardisation is an important issue for industry wide application frameworks such as ICM.

III. Foundations of The Application Frameworks

Though application frameworks is not exclusive to object-oriented community the majority application frameworks are developed and implemented using object oriented technology. Object-oriented technology is one of the fastest growing technologies of the last two decades promising better quality, productivity and interoperability through software reuse. Coad and Yourdon [9] define "an object is an abstraction of something in a problem domain, reflecting the capabilities of the system to keep information about it, interact with it or both". In that sense objects are used to model an understanding of the application domain, which concerns the system and abstraction. Deitel [11] defines "Object technology is a packaging scheme that facilitates the creation of meaningful software units". He explains that these units are usually large and focused on particular application areas and most of them can be reused. For example, there are data objects, time objects, audio objects, video objects, file objects, record objects and so on.

The central idea of the object-oriented technology subsumes abstraction, modularity, encapsulation, inheritance and polymorphism - concepts that, on the face of it, lend themselves to reuse. The notable development of the technology consists of a comprehensive set of object-

oriented modelling methods for analysis, design, and implementation, designed to realise the concepts mentioned above. Consequently, object-oriented technology has led to the development of patterns, components and application frameworks. The object-oriented concepts have been applied in the process of developing and implementing application frameworks. Fayad [15][16][17] stresses that frameworks build upon object-oriented concepts, which provides a conceptual base for more complex programming constructs and reusable implementation structures for large systems application. Eliens [13] states that object oriented approach will pay off when we have arrived at stable abstractions from which we have good implementations, that may be reused for a variety of other applications. Application frameworks is a technology aimed to achieve large-scale reuse by applying object-oriented concepts. In the following sections some of the object-oriented concepts and principles will be explored in relation to application frameworks and systems development.

IV. Application Frameworks and Other Reuse Techniques

Application frameworks is a reuse technology aimed at large-scale reuse and it has a close relationship with other reuse techniques used in software engineering. An application framework is a collection of components, a generic solution for a class of problems, a frame of mind for solving problems and a set of architectural constraints. An application framework integrates and concretises a number of patterns to a degree required to ensure proper interleaving and interaction of participants involved. An application framework is a kind of library, which provides reusable objects for applications but in contrast to ordinary software class libraries, frameworks may at times take over control when the application runs. From reuse perspective the application frameworks technology is closely related to other reuse techniques such as patterns, class libraries and components. Application frameworks use those reuse techniques mentioned above to achieve the goal of large-scale reuse.

IV. 1 Architecture

Software architecture is the foundation of system construction. Graham [21] defines "Software architecture deals with abstraction, with composition and decomposition, and also with style and aesthetics. Bass et al. [3] describe, "The software architecture of a program or computing system is the structure or structures of the systems, which comprise software components, the externally visible properties of those components and the relationships among them". While, Szyperski [33] depicts "System architecture is a means to capture an overall generic approach that makes it more likely that concrete systems following the architecture will be understandable, maintainable, evolvable, and economic. It is this integrating principle, covering

technology and market that links software architecture to its great role model and justifies its name". Despite the different concentration of the definitions above a software architecture is about an over view of a system. Generally speaking software architecture can be seen as a set of rules, guidelines, interfaces, and conventions used to define how components and applications communicate and interoperate with each other. Recent software development experience has proven that sound software architecture for the software systems is necessary as software systems are more complex than before. Szyperski [33] stresses that architecture prescribes proper frameworks for all involved mechanisms, limiting the degree of freedom to curb variations and enable cooperation. Architecture needs to be based on the principal considerations of overall functionality, performance, reliability, and security. Software engineers have learnt from practice such that architecture is needed in any systems if they seek for guiding rules for design and implementation.

Architecture needs to create simultaneously the basis for independence and cooperation of systems. Independence of systems aspect is required to enable multiple sources of solution parts. Cooperation between these otherwise independent aspects is essential in any non-trivial architecture. System architecture is the structure of a software system, which provides a platform for application developers to build the system. It may be as concrete as providing detailed implementation requirements to as abstract as given a generic idea of how the system should be implemented. Application frameworks technology promises reuse of not only the frameworks source code, but also more importantly architecture [15]. A standardisation structure allows a signification reduction of the size and complexity of code that application developers have to write.

IV. 2 Class libraries

Class libraries is as set of reusable classes, often defined as part of the implementation or design environment [34]. Many programming languages have some ready usable classes embedded available to application developers especially visual development such as VB Studio.Net and J2EE. Class library in general offers static inheritance facilities but framework is more likely to support dynamic, run time binding facilities. Application frameworks defines 'semicomplete' applications that embody domain specific object structures and functionality. It can be viewed as extensions to object oriented class libraries. In contrast, class libraries provide a smaller granularity of reuse. For example, class library components like classes for strings, complex numbers and arrays are typically low-level and more domains independent. Fayad [18] states that class libraries are typically passive and frameworks are active and exhibit 'inversion of control' at runtime.

IV. 3 Patterns

Classes and interaction structure of object-oriented designs may become fairly complex, and consequently difficult to

develop and understand, which have led the study and development of patterns. Design patterns are standard solutions to recurring problems, named to help people discuss them easily and think about design. Design patterns can be used as a micro-architecture that applies to a cross-domain design problem such as linked list and other classical data structure design. A design pattern describes a concrete solution to an architectural problem that might arise in a specific context. The solution proposed by the patterns is typically a way of structuring a cluster of objects and their interaction [7]. Schmid [31] states that the repetitive use of design patterns created an overall architecture though each design pattern represents a micro architecture. He argues that design patterns give a better, since more concrete guidance for how to realise a framework. Patterns are abstract, therefore, are not ready-made pluggable solutions. They are most often represented in object-oriented development by commonly recurring arrangements of classes and the structural and dynamic connections between them. Graham [21] argues that patterns are most useful because they provide a language for designers to communicate in. In particular, design pattern have proven their value in structuring the variable parts, called hot spots (allow plug in software artefacts) of a framework [28]. Fayad [17] defines patterns as a conceptual solution to a recurring problem. Schmid [31] argues that design patterns are an excellent means to describe the details of object and class interactions but they are not suited to give an overall picture. Design patterns are reusable architecture, object template, or design rule that has been shown to address a particular issue in an application domain [34]. Most of design patterns come either as a static description of a recurring pattern of architectural elements or as a rule to apply dynamically for when and how to apply the pattern. The majority of software patterns produced to date have been design patterns at various levels of abstraction but Fowler and Graham [20][21] introduce the idea of analysis patterns as opposed to design patterns. Fowler's patterns are reusable fragments of object-oriented specification model generic enough to be applicable across a number of specific application domains.

Patterns and frameworks both facilitate reuse by capturing successful software development strategies. The primary difference is that frameworks focus on reuse of concrete designs, algorithms, and implementations in a particular programming languages. In contrast, patterns focus on reuse of abstract designs and software architectures. Frameworks can be viewed as a reification of families of design patterns. Likewise, design patterns can be viewed as the micro architectural elements of frameworks that document and motivate the semantics of frameworks in an effective way [18]. Design patterns have been used extensively in developing application frameworks. Many researchers [15][17][31] have suggested using as many patterns as possible for developing application frameworks because the abstractness and design expertise are embedded in patterns.

IV. 4 Components

Szyperski [33] points out that component technology is standalone, which has gone beyond object orientation. He defines "software components are binary units of independent production, acquisition, and deployment that interact to form a functioning system". In that definition a software component is best thought as a unit with well-defined interfaces and has explicit context dependencies. He explains that insisting on independence and binary form is essential to allow multiple independent vendors and robust integration. Components are not just a big object. Eliens [13] describes that components usually consist of a collection of objects that provide additional functionality that allows components to interact together. Szyperski [33] states that component is a unit of independent deployment, a unit of third party composition, and it has no persistent state. By contrast, an object is a unit of instantiation, which has a unique identity, it has state, which can be a persistent state, and an object encapsulates its state and behaviour. A component is likely to come to life through objects and therefore would normally consist of one or more classes or immutable prototype objects. Component oriented programming requires the support of polymorphism and modular encapsulation [33].

A component has well-specified functionality with standard interface and behaviours, and a concrete implementation of an area of the system. Components in a framework provide a generic architectural skeleton for a family of related applications and complete applications could be composed by inheriting from and /or instantiating framework components. Atkinson [1] states that there are two types of relationship between component instances that are important at runtime. The first is composition, which captures the idea that one component is a part of another. The key aspects of the composition relationship are: 1. Composite objects are responsible for the creation and destruction of their parts. 2. The parts of a composite object take their identity from their composite object. 3. Composition is transitive. The other one is the client/server relationship. A client/sever relationship between two components instances defines a contract between them. For components to be independently deployable, their granularity and mutual dependencies have to be carefully controlled from the outset.

Component and application frameworks have close relationship. Many application frameworks use Common Object Request Broker Architecture (CORBA) to increase the interoperability among each part of the framework. CORBA, a big component essentially has three parts: a set of invocation interfaces, the Object Request Broker (ORB), and a set of object adapters. For invocation interfaces and object adapters to work, two essential requirements need to be met. First, all object interfaces need to be described in a common language. Second, all languages used must have bindings to the common language [33]. Fayad [18] states

that frameworks can be used to develop components. Equally, components can be used in blackbox frameworks.

V. The Analysis of Current Application Frameworks Practices

There are a number of application frameworks projects developed during the 90's including some notable domain specific application frameworks such as San Francisco, OSEFA, and SEMATECH CIM. The application frameworks research community has accumulated considerable experiences in some domains such as finance, manufactory and telecommunications about building and implementing application frameworks in the last decade. The followings are core experiences identified during the study:

V. 1 Object-oriented concepts applied

Object-oriented application frameworks approach takes advantage of object-oriented concepts such as abstraction, inheritance, encapsulation and polymorphism as well as the use of object-oriented programming language. Though application frameworks is not exclusive to object oriented technology, the object-oriented concepts have a great impact on the development of application frameworks as a foundation of building and implementing application frameworks.

V. 2 Large-scale reuse

Application frameworks is different from other reuse techniques such as code reuse, design pattern reuse, class library and component reuse. It is aimed at achieving large-scale reuse in which the application developers are not only reuse the code but also the module and architecture of the application frameworks.

V. 3 Domain specific

Application frameworks is likely domain specific such as a financial framework or manufacturing framework. A domain specific framework extracts domain expertise and current solutions of the domain. Domain knowledge is crucial for developing application frameworks, which can be extracted from the domain experts and the current solutions of the domain. The development of application frameworks in some domains has accumulated more experience than others.

V. 4 Existence in any development stage

Concerning the scope of reuse and development process, an application framework can be as abstract as analysis framework or more concrete as implementation framework. Majority of the researchers tend to agree that application frameworks is a kind of semi-completed applications and the reuse can potentially exist in any development stage such as analysis, design and implementation.

V. 5 Development approaches

Though it is not proven that the object-oriented technology is the only way to develop application frameworks, most of the applications frameworks are developed by using the object-oriented technology. Iterative and incremental development approaches have been the main development methodology supporting the development of application frameworks. Framework design can be bottom-up and pattern driven or top-down and target driven.

V. 6 Issues identified to date

Application frameworks research has shown considerable achievement in the context of systems development. However, some obstacles have been identified during the study involving in the theory and practice of application frameworks using object-oriented technology. The issues are organised into the sections of 3.2.1 to 3.2.9.

V. 7 Developing and implementing effort

Developing application frameworks is hard. Due to the complexity, size of application frameworks, and the lack of understanding of framework design process, application frameworks is usually designed iteratively requiring substantial restructuring of numerous classes and long development cycles. Implementing application frameworks is as hard as developing application frameworks. A framework conventionally consists of the core classes of an application, and one has to understand the basic architecture of a particular application type to be able to specialise the framework.

V. 8 Infrastructure coupling

The application developers will have to rely on the architecture structure defined by the application framework while implementing the framework. Infrastructure coupling is very difficult to avoid for a whitebox framework since inheritance is the main mechanisms of implementing the framework that cause widespread coupling (the result of extensive use of inheritance), and consequently restrict the extendability of the application developed by the framework. In contrast, the traditional object-oriented development approach can eliminate the problem by reducing the unnecessary use of inheritance.

V. 9 Combining frameworks

Combining frameworks is not a straightforward task. One of the perceived advantages of using application frameworks is to increase extendability [17]. However, combining two or more frameworks without breaking their integrity is difficult because a framework assumes that it has the main control of an application [29]. Also, the difference of architectural style is another problem, which may potentially prevent two frameworks from combining together [4]. It is also difficult to combine applications developed from a framework with legacy systems because the new application generally contains behaviour for internal framework functionality in addition to the domain specific behaviour, but the legacy system in general only has the functionality of the domain.

V. 10 Overlap and potential gap

Application frameworks is often developed to capture specified domain knowledge. A domain specific application framework is a skeleton of architecture for a domain. It is possible in practice that the real world entity can be classified into different domains and consequently stored in different application frameworks. In application, it is desired to have only one object to represent the real world entity (single inheritance). The entity overlapping in different frameworks may confuse the applications building based on two or more frameworks. Also, potential gap may exist among two or more frameworks because it is possible that two frameworks cannot still be able to meet an application's requirement. In that situation substantial effort is needed to modify the design of the application or using mediating software [4]. In either case the implementation becomes very complex and difficult to handle.

V. 11 Testing

There is little research relating to frameworks testing. According to the nature of application frameworks, a framework is 'a skeleton of structure' with the notion of abstraction. It would, therefore, be very difficult to conduct testing. Currently, most of the researchers are testing the applications developed from the framework and iteratively evolve the framework. A well-designed framework component typically abstracts away from application specific details, however, it increases the complexity of module testing since the components cannot be validated in isolation from their specific instantiations [14]. It would be difficult to test the application developed using calling frameworks in which the frameworks calls the application when the application runs. It could be complicated to follow a thread of execution, which was mostly buried under framework code.

V. 12 Documentation

Documentation is used by both the framework developers and application developers who implement the framework. Fayad [17] classifies it into two categories such as for framework developers, which is used to modify and enhance the structure as well as the performance of the framework, and for application developers, which is employed to understand and use the framework. The current research indicates the documentation is still inadequate for application developers, which has potentially increased the difficulty of the learning curve [17]. The current documentation approach (text plus model diagram plus code example) is often difficult to acquire understanding of frameworks.

V. 13 Maintenance

Current research has no indications of that the requirement for maintenance would be reduced by adopting application frameworks approach. As a long-term investment, frameworks evolve over time and need to be maintained.

Most of the application framework developments adopt iterative and incremental development strategy. Thus, when a change made to a framework the applications developed using the framework will be affected as well because the application use the structure and partial code of the framework. In this case the application development must be delayed if the major new version of the frameworks is about to be available in the near future. The company may have even to maintain more than one version of the framework since there may exist applications based on the old version of the framework.

V. 14 Feasibility

There is little feasibility study conducted in the area of application frameworks. However, OSEFA discloses the cost issue and states that developing a blackbox framework takes around two to three times as much effort as developing a fixed application from the domain. Reusable framework like other reusable technologies is only as good as the people who build and use them. Developing robust, efficient, and reusable application frameworks require the project team to have a wide range of skills. It needs expert analysts and designers who have mastered design patterns, and software architectures and expert programmers who can implement these patterns and architectures in the application framework. Even though it may be feasible to develop a framework for a particular domain from a technological perspective it is not necessarily advantageous from a business perspective. The return on investment from a framework developed may come from selling to other companies, but to a large extent, relies on future savings in development effort within the company itself. However, future earning is not obvious to be justified as the technology itself and business environment is changing. It is difficult to estimate the amounts of work required for a specific application. It is also difficult to foresee if a specified business requirement is supported by the framework.

VI. Conclusions

The application frameworks technology supports large-scale reuse and increase the quality of the software products. An application framework can be described as a skeleton of software systems upon which application developers are able to build applications. Though application frameworks is not exclusive to object oriented technology, most of the current work is coming from object-oriented community. Application frameworks have a close relationship with object-oriented technology in which object-oriented principles are adopted. The results of the study indicate that application frameworks technology is still immature and not yet to be another silver bullet but potential is imminent. The experiences accumulated by the research community indicate that application frameworks apply object-oriented concepts, aimed at large-scale reuse, likely domain specific and can exist in any development stage. Also, some issues relating to application frameworks have been identified in terms of development and implementing effort,

infrastructure coupling, combining frameworks, overlap and potential gap, testing, documentation, maintenance and feasibility. Applications developed by implementing application frameworks may increase quality in terms of correctness and reusability with some penalty factors. The extendability and interoperability may be reduced due to the high inheritance coupling nature of the application developed from application frameworks. The results of the study suggest that the use of application frameworks technology has made a difference in systems development in terms of: (1) a number of application frameworks such as GUI, San Francisco and CIM frameworks have been developed and used by industry; (2) application frameworks technology supports large-scale reuse by incorporating with other existing reuse techniques such as design patterns, class libraries and components. The results of the study discover that the methodological support concerning building and implementing application frameworks is inadequate. The results of the study also point out that one of the claims, made by the advocates of application frameworks technology regarding the technology can increase the extendability of the software systems developed by application frameworks, are debatable.

VII. Future Work

Application frameworks technology may become one of the promising technologies in systems development if the following two research areas achieve significant breakthrough in the future. (1) Methodological study especially, the process of building and implementing application frameworks. (2) Solving technical issues related to building and implementing application frameworks such as how to increase the interoperability and extendability in frameworks approach.

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The Novel ICT Strategic Model for developing of ICT in Public Universities based on BSC

Ubonsin Poprom *, Prasong Praneetpolgrang **, Preang Kitratporn ***

* Project Office for Consortium on Doctor of Philosophy Programs, Phranakhon Rajabhat University, 3 Moo 6 Jangwattana Rd.
Bangkhen Bangkok, 10220 Thailand,
Email : ubonsin@yahoo.com

** Master of Science (Information Technology) Graduate School,
Sripatum University, 61 Phaholyothin Rd, Jatujak
Bangkok, 10900 Thailand
Email : prasong@spu.ac.th

*** Project Office for Consortium on Doctor of Philosophy Programs,
Phranakhon Rajabhat University, 3 Moo 6 Jangwattana Rd.
Bangkhen Bangkok, 10220 Thailand
Email : preang@pnu.ac.th

Abstract: The purposes of this research were to evaluate Information and Communication Technology (ICT) management of public universities in Thailand using balance scorecard (BSC) and to develop key performance indicators (KPIs) of ICT in order to develop new ICT strategic model. This proposed model provide some guidelines to improve Investment and worthwhile ICT management and to conform with strategies of universities. The research methodology were both qualitative and quantitative research. The findings of this research showed how universities have been developed ICT as strategic management and the efficiency of ICT management. Further more, the specific KPIs have been created to measure and follow up the use of ICT. Then, the proposed ICT strategic model could apply to other public organization.

Keywords: ICT strategic model; KPIs; BSC.

I. Introduction

Since, all 41 campuses of Rajabhat University have been used ICT to service students and employee and to support administration. The amount of spent on investment of ICT is quite high and keep on increasing with time[1]. The usability of ICT equipment is not suitable, break even and used not extremely benefit[2]. Because of management is not suitable, policies and strategies of ICT can not be executed in reality. Moreover, Evaluation and monitoring of ICT management were proceed. The balanced scorecard (BSC) soon be came a tool for managing strategy[3]. Strategic Implementations were using measurement to align their business units, shared service units, team and individuals around overall organizational goal[4]. The BSC emphasize that financial and non-financial measures[5]. It has been implemented in companies to both measure as well as manage the IT effort[3], [4], [5], [6]. BSC has many dimension for execution decision and to mange all level of

strategies. It combines objective, planning, initiatives and measures with organization strategies[7]. Measure results would be data for evaluation of ICT management[8]. Because of problems to use ICT is not suitable and to execute strategic ICT effort. Researchers have studied to find suitable methods for ICT management. It also use BSC principles to create strategy by emphasis Implementation. The ICT strategy align with strategic themes of university. It set the role of ICT suitable business base on IT Maxim[9]. The result of this evaluation of ICT management developed key performance indicators (KPIs) and ICT strategic model for Rajabhat Universities.

II. Related Research

The researchers have conduct a study on information technology management, information technology evaluation and relevant researches, used for the concepts and theories related to this research, as follows:

II.1 An Information and Communication Technology Management

In order to obtain strategies for information and communication administration strategic administration is an administration on systematic planning and plan implementation and the actual operation as to the set plan, the strategic planning for information and communication technology is also a mechanism of strategic administration for information and communication technology so that such plan would be actually beneficial to the organization. Therefore, the strategies of the university together with the demand for information and communication technology to be used to create or to support the main university strategies must be mainly considered.

II.2 IT Maxim

Creating business driven IT infrastructure involves a series of decision points based on a sound understanding of the firm's strategic context. This understanding of the firm's strategic context. This understanding is articulated and communicated through a series of business maxims. Business maxims lead to

the Identification of IT maxims which express how information technology resources should be deployed and the way in which information and data needs to be accessed and used [9].

II. 3 The evaluation of Information and Communication Technology management.

The benefits gained from the measurement would cause the evaluation on the IT administration [10]. The evaluation on ICT is considered the first step of strategic planning and the result from the evaluation would generate strategy creation[13]. In the past, many people tried to search for various evaluations on ICT administration, especially the economic-conceptualized evaluation [12], which did not give an importance only to the financial aspect but the evaluation on the utmost benefits gained from the resources [13]. The worthiness of ICT investment as a part of ICT administration can be mainly concluded as follows:

1. Benefit

The evaluation of ICT reward divides tangible benefits and intangible benefits by considering the role of ICT [9], ICT capacity [5], ICT by-product and actual benefit affecting the organization operation[15],[16].

2. Cost

In the past ICT use in organization increased. The important point for considering ICT investment is the cost reduction which extremely saves the cost [2] in terms of suitable ICT investment for organization operation, service providing and good management. The cost would correspond to the benefits for the society or the organization.

3. Risk

The risk in the evaluation comprises the evaluation of ICT investment risk before the investment [14] by analyzing the possible risk [12]. A good evaluation must give an importance to the risk management [12].

4. Customer satisfaction

IT is used to create customer satisfaction to attract customer group [12], [15].

II. 4 Balance Scorecard Principle

Balance Scorecard (BSC) is a concept developed from "The Corporate Scorecard" or the Balanced Scorecard" of Kaplan & Norton[5],[6]. It is a tool leading to the strategic Implementation by measurement which would create unity to the organization and lead to organization achievement[3],[4],[5],[6]. Researchers use BCS base on 4 perspectives which are financial, customer internal business process and learning and growth to evaluate ICT management. Moreover develop a suitable model for ICT management for Rajabhat Universities by emphasis on reality .

III. Research Methodology

The research methodology were both qualitative and quantitative research. The population are 41 campuses of Rajabhat University. The sampling group into 4 groups follow 1) Board of University who have duty and responsibility of ICT management, 2) Middle manager who control and manage ICT policies to proceed, 3) Group of person who concern with ICT

and 4) Students. The data collecting use interview and observation for the sampling group 1 and questionnaire for the sampling group 2,3 and 4. The data analysis use content analysis and interview for qualitative data and analyze questionnaire for quantitative data. The researchers use Delphi technique analysis from professionals to analyze accordance of opinion about developmental strategic model.

IV. Preliminary Results

From the interview with the chief Information Officer(CIO) in Rajabhat Universities and from the analysis on the document contents, the preliminary data of the research under the BSC is as follows:

IV. 1 Financial Perspective: It Was Found That:

1. For the budget allocated for ICT, 66.67% was not appropriate and only 33.33% was appropriate.
2. The budget for ICT was not clearly defined but up to demand and emergency.
3. Most CIO see that ICT investment is worthy.
4. The ICT administration for earning income to the university was very low.

IV. 2 Customer Perspective : It Was Found That:

1. Demand on ICT usage increased.
2. Demand on advanced technology existed.
3. Demand on network with hi-speed data transfer existed.

IV. 3 Internal Business Processes Perspective : It Was Found That:

1. Only 66.67% of ICT administration with ICT master plan was found
2. The university could actually implement only 52.5% of the master ICT plan.
3. ICT development as to the master plan was very low 16.67%.
4. 83.33% of the executives agreed with the development of e-university.
5. Problems and difficulties found: Lack of technical specialists, lack of consistent budget support, the actual performance did not correspond to ICT policy and Teacher/Staff did not adjust themselves Improper use.

IV. 4 Learning and Growth Perspective : It Was Found That:

1. Lack of monitoring and evaluation to review ICT policy.
2. ICT users were not certain that they would gain any benefits or sustainable knowledge.
3. The university had not enough programs or projects to develop the quality of ICT human resource.

The next part of questionnaire survey asked respondents to detail what ICT management from middle managers, employee and students all 41 campus at Rajabhat University.

V. Proposed ICT strategic model

Kaplan & Norton,[4][5][6] suggest BSC that aims to balance the traditional perspective of accounting for intangibles by adding four perspectives related to: innovation and learning business process improvement, customer relationship, and , value creation in financial and intangible terms. In contrast to other tools, this proposed model provides an integrated focus on both management and measurement systems for management with focus on financial and non-financial indicators relevant to organizational performance. Broadbent & Weill[9],proposes the ICT used to align with business. The ICT strategy align with strategic themes of universities[3]. It set the role of ICT suitable business IT Maxim[9]. The proposed conceptual model is detailed in this paper for consideration when ICT investments is worthwhile and suitable. It is divided into six hierarchical levels of ICT management ; strategic themes, ICT for Rajabhat University, an evaluation of ICT management , KPIs, ICT strategic map and Implementation.

V. 1 Strategic Themes :

The framework begins with consideration of the Rajabhat university wide strategic context, synergies Amongst business units and the extant to which the firm wishes to exploit those synergies. Strategic themes are derived from the strategic context and identify the future concern of the Rajabhat Universities as whole.

V. 2 Identifying ICT RU :

The ICT RU (Information and Communication Technology for Rajabhat University) are statements which how ICT needs to support main missions of university. The ICT RU express the way in which information and data to be accessed and used. In addition, what technology resources need to be deployed to ensure adequate technical capabilities, integration and standards. The expectations for ICT investment are classified in terms of the balance between short term cost with minimum investment level and future options and flexibility which might require an over investment based on current need.

V.3 An Evaluation of ICT Management Using BSC:

An evaluation methods that are very popular and used widely at the present. This method does not consider only results of goal achievement but also considers linking about vision, mission, and content strategies. The BSC provides executives with a comprehensive framework that translates the university's vision and strategy into a coherent determination of performance measures.

V. 4 KPIs.

Key Performance Indicators are evaluation result of ICT Management base on four perspective of BSC.

V. 5 ICT Strategic Map

BSC can be used within the ICT department to assess its own performance as well as to integrate itself to organization as a whole[3]. There are a variety of approaches to implementing on ICT scorecard.

V. 6 Implementation

This is the implement part of proposed ICT strategic model. Since, it can proof that if this model is suitable in practices.

VI. Conclusion

From the CIO' opinions, it was found that ICT investment was fairly worthy. From the management's opinions, it was found that the policy of the master plan did not correspond to the actual operation. The master plan could create knowledge learning process to the operations at a level and the operations could obtain knowledge on ICT use. Moreover, it was found that related parties as staff and student were satisfied, at a level, to gain or use ICT service. From the staffs' and students' opinions, it was found that ICT was beneficial to them. They were satisfied at a level and learned how to use ICT. They also need the operation which could make the service or the use to be extremely corresponding to the demand. An evaluate result of ICT management could be develop key performance indicators KPIs). The alignment between technology and the organizational processes using the balance scorecard methodology requires a redefinition of ICT management and can provide some guideline to improve Investment. This paper has sought to emphasize the importance of a structured evaluation framework to evaluate ICT management. The BSC approach was chosen as the template for this model due to its success in wide spectrum of organizations. The model is in this paper with ICT performance perspectives and indicators developed specifically for ICT management.

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The Impacts of National Cultures on Customer Relational Benefit – Loyalty Link: A Study of the Chinese Community

HsiuJu Yen¹, Eldon Y. Li², Yiping Song³

1 National Central University, Chung Li, Taiwan

2 National Chengchi University, Taipei, Taiwan

3 Fudan University, Shanghai, China

I. Introduction

Developing and maintaining enduring relationships with customers have been becoming a major business emphasis over the past few years. Most of previous studies focused on the benefits of establishing long-term customer relationship for the firms, but the maintenance of successful relationships would be affected by the benefits received by the customers too. Marketing literature suggested that various types of customer relational benefits (CRB) exist, and the fulfillment of these benefits predicts the future development of the existing relationships (Bendapudi and Berry, 1997; Gwinner, Gremler, and Bitner, 1998; Reynolds and Beatty, 1999). The research by Gwinner et al. (1998) represents the most extensive study of CRB, which suggested that CRB should encompass three factors: confidence, social and special treatment benefits. Recently, Hennig-Thurau et al. (2000) proposed that consumers would stay in a relationship with a service provider that is capable of adding meaning to their self-concept, and the relational benefits is named as identity-related benefits.

Until now, academic research on CRB has been conducted almost exclusively with North American consumers with few exceptions. Pattern and Smith (2000; 2001) replicated the study of Gwinner et al. (1998) in Asia and found that people from Thai considered special treatment benefits as a benefit more important than their American counterparts. Because the nature and development of relationships is highly culturally dependent, the reliance on U.S.-based research has left a large gap in our understanding of CRB in different cultures. Abundant of studies have evidenced the influence of cross-culture difference on service quality perceptions. For example, several studies discovered that service quality dimensions are affected by cultural factors (Winsted, 1997; Mattila, 1999; Liu et al., 2001; Furrer et al., 2000). Also, consumers' expectation of service quality varied as a function of four Hofstede's (1991) cultural dimensions (Donthu and Yoo, 1998). Although these studies did not address the cross-cultural issues of relational benefits, the close bonding between service quality and relationship marketing would imply the possible influence of cultural factors on the link between CRB and customer loyalty.

While most studies tend to treat consumers within countries as homogeneous and to segment the market based on clustering countries, literature also calls for the needs to consider the difference within countries and similarities across countries for international segmentation (Kale and Sudharshan, 1987). In accordance with this argument, Furrer et al. (2000) found significant correlations between SERVQUAL dimensions and Hofstede's (1991) cultural dimensions while cultural inclination was measured at the individual level. The approach to consider the cultural heterogeneity with nations or clustering countries should become more prominent as Internet and other communication medium have expedited the exchange of cultures globally. This might be particularly true for the Chinese community (i.e., Hong Kong, China, Taiwan) that has experienced a lot of economic transformation and a great deal of influences from Western cultures. However, it is also noticeable that some people in the community are more receptive to the influence of western culture while others are affected to a lesser degree.

II. Research Purpose

The current study aims to investigate the influences of cross-cultural influences on CRB-loyalty link in the Chinese community. Specifically, this study explores whether the importance of CRB on loyalty is a function of the individual's inclination on Hofstede's cultural dimensions in two different regions of the community. As service providers increasingly expand their operations into Asia countries, developing a thorough understanding of the relational benefits that consumers desire in Asia cultures will be of growing importance.

III. Research Method

College and graduate students are the primary data collectors for the current study. They were recruited from two universities in Shanghai, China and Taiwan, and they have distributed the survey to their friends, families, and colleagues. This has been a successful technique for data collection in previous studies (e.g., Gwinner et al., 1998; Hennig-Thurau et al., 2002). The final sample consists of 942 (471 from eastern China and 471 from Taiwan) usable cases. The subjects were asked to answer questions assessing customer relational benefits based on their prior experiences with a service provider. The questionnaire also measured the respondent's inclination on the four Hofstede's cultural

dimensions.

IV. Analyses and Results

Exploratory factor analyses on the data revealed four factors for Hofstede cultural measures and four CRB factors (confidence, social, special treatment, and identity), which is consistent with the proposed constructs of two sets of variables. Independent sample t-tests were first performed on the major variables. Compared with eastern China, respondents from Taiwan reported a higher level of social, confidence, and identify benefits. Taiwan respondents also scored significantly higher on "uncertainty avoidance", and significantly lower on individualism and masculinity. Multiple regression analysis was then conducted to test the influence of the four CRB factors on customer loyalty to the service provider in the two regions. In both regions, confidence and identify benefits are the strongest predictors of loyalty ($\text{Beta's} \geq .354, p < .001$). However, the regression analysis revealed a different third predictor of customer loyalty for each region. For respondent in eastern China, special treatment benefit is the third predictor of their loyalty to the service provider, while social benefits is the other significant predictor of loyalty in Taiwan. In order to compare the results with the findings from Gwinner et al. (1998), another regression analysis was performed without including the new CRB, identity-related benefits. The findings are similar to the study with American subjects, with confidence benefits as the most important predictor of customer loyalty.

In order to explore the relationship between cultural influence and CRB, the current study applied two step clustering analysis to group the respondents from the two regions. The hierarchical clustering analysis suggested that the three-cluster solution has the best fit with the data. K-means clustering analysis was then performed to group the respondents into three clusters. Cluster 1 is characterized as highly collective, high uncertainty avoidance, high power distance and high masculine, which match the stereotype of traditional Chinese. Cluster 2 is consisted of respondents score relatively lower on the four Hofstede's cultural dimensions, and can be conceptualized as modern Chinese. The third cluster is made of respondent similar to cluster 2 but with higher emphasis on achievement and individualism.

A series of regression analyses was performed for each cluster to test the effects of CRB on customer loyalty. The analyses showed that "confidence" and "identity-related" benefits are significant predictors of customer loyalty in all three clusters (all $\text{Beta's} \geq .265, P < .001$). For cluster 1 that is comprised of traditional Chinese, social benefits is another significant predictor of loyalty ($\text{Beta} = .106, p < .05$). Special treatment benefit is the other significant predictor of loyalty for cluster 2 ($\text{Beta} = .120, p < .05$), while no additional significant predictor was found for cluster 3.

V. Conclusion

The findings from the current study provide further support to the presence of heterogeneous culture in Chinese community. Quanxi has been a dominant concept in Chinese society, and the significance of social benefits in cluster 1 suggests that "relationship" itself is still a key determinant of loyalty for traditional Chinese. On the other hand, for Chinese consumers that have been affected by the modernization in recent decades may also look for economic and additional services as the benefits of staying in a relationship with a service provider. And that's why special treatment benefits emerged in cluster 2. The results offer important implications for marketing services and implementing CRM programs in the Chinese market and confirm the argument that consumers in the same cultural context may exhibit heterogeneous cultural patterns.

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Consumers Trust in Online Shopping: The Case of Singapore

Hui Tak Kee *, Mak Kok Sun **

* NUS Business School National University of Singapore
Kennt Ridge, Singapore 12345
EMAIL: bizhuik@nus.edu.sg

** School of Business Monash University Malaysia
Bandar Sunway, 46150 Petaling Jaya, Malaysia
EMAIL: mak.kok.sun@buseco.monash.edu.my

Abstract: The emergences of the Internet and World Wide Web have changed the way businesses ply their trades. Many organizations now have established an online presence, particularly businesses that provide products or services directly to consumers, the so-called business-to-consumer (B2C) e-business. Trust is an important component for the continued viability and success of online businesses, as unlike traditional businesses, consumers do not have physical contact with the products to evaluate their suitability and quality. In this paper, we adopt the trust model constructed by Lee and Turban [7] to study how the drivers of trust in B2C e-commerce would affect the level of trust consumers have in online shopping in Singapore. We will also investigate if there are any moderating effects due to consumer' trust propensity on the relationship between each trust driver and consumer trust in online shopping. Our results show that most of the trust drivers identified by Lee and Turban have a positive effect on the level of trust on online shopping and trust propensity also has a moderating effect on the relationship between the trust drivers and consumers' trust in online shopping.

I. Introduction

The emergences of the Internet and World Wide Web and the rapid growth of the number of Internet users have changed the way businesses ply their trades. Due to higher scalability, wider market reach and lower costs, many organizations have established an online presence, particularly business that provide products and services directly to the consumers, the so called business-to-consumer (B2C) e-business.

According to Internet World Stats, the number of Internet users in Singapore has grown from 1.2 million in year 2000 to 2.135 million in 2005 [11]. But according to a survey of Singapore Internet Project in 2001, it was still quite rare for a Singaporean Internet user to make purchases online for personal purposes, only 8.1% did so in the past 12 months [12]. The risks involved in online purchases could be a possible reason for the low number of Internet users to make online purchases. Consumers generally perceive risks associated with online shopping to be higher than traditional shopping in physical stores as the products and services provided by online vendors are virtual, intangible and

heterogeneous and assessment of their suitability and quality is inherently difficult and uncertain ([2], [4], [9]). Furthermore, the 'invisible' nature of e-business may give rise to opportunistic negative behaviors such as overcharging to increase sales volume ([3], [10]). Thus, trust in online buyer-seller relationship plays a crucial role in the success of online business and it has gradually become an essential competitive tool in B2C e-commerce and is deemed critical for the success of e-commerce ([1], [5]). Furthermore, "lack of trust is one of the most frequently cited reasons for consumers not purchasing from online shops" [7]. Thus, it is important to know the factors that influence consumers' trust in online shopping so that trusting relationships can be developed between sellers and buyers. This would very likely lead to higher profits as consumers "with a higher level of trust in e-commerce are more likely to participate in e-commerce" [2] and purchase more items online more frequently.

Past researches have extensively examined, in both conceptual and empirical frameworks, the various drivers of consumer trust in online shopping. In this study, we would adopt the trust model proposed by Lee and Turban [7] (with some slight modifications) to determine the effects of the various trust drivers on consumers' trust in online shopping and also to determine the moderating effects of trust propensity of consumers could have on the relationship between each trust driver and consumer trust in online shopping in the Singapore context.

II. Literature Review

Past researchers have used both the conceptual and empirical approaches to study the drivers of trust in online shopping. Studies on trust using the conceptual approach can be found in [1], [5], [8] and [10], while those using the empirical approach can be found in [2], [3], [4], [6], [7] and [9].

The general notion of trust has been examined and discussed extensively in the past in different disciplines such as sociology, psychology and marketing [4], [7]. However, trust in e-commerce has only been explored recently. Lee and Turban define trust in e-commerce as "the willingness of a consumer to be vulnerable to the actions of an Internet merchant in an Internet shopping transaction, based on the expectation that the Internet merchant will behave in certain agreeable ways, irrespective of the ability of the consumer to monitor or control the Internet merchant" [7], while

Kolsaker and Payne define trust as “the dimension of a business relationship that determines the level to which each party feels they can rely on the integrity of the promise offered by the other” [6]. In general, it is recognized that trust in e-commerce is a complex process and multi-dimensional as it involves not only trust between humans but also trust between humans, machines and the ‘invisible’ entity Internet. As stated in [7], online shopping “involves trust not simply between the Internet merchant and consumer, but also between the consumer and the computer system through which transactions are executed”.

The trust model proposed and tested by Lee and Turban [7] is adopted in this study. The components that influence consumers’ trust in online shopping in the model include trustworthiness of the Internet merchant, trustworthiness of the online shopping medium, online shopping contextual factors, other factors and trust propensity.

‘Trustworthiness of the Internet Merchant’ involves assessing the ability, benevolence and integrity of the online seller, which collectively represent its reputation [7]. Ability refers to the online vendors’ competence in achieving the results desired by the consumers and benevolence involves the online vendors’ motivation to act in the interest of their online customers. Integrity reflects the vendors’ honesty and dependability in fulfilling their promises and obligations ([1], [3], [8]). An online vendor that is consistently willing and able to serve consumers’ interest is likely to be rewarded with a high level of consumer trust. Thus, ability, benevolence and integrity of online merchants are expected to positively affect the level of consumer trust in online shopping. In this study, we will examine the effects of perceived ability, benevolence and integrity of online vendors could have on Singaporean consumers’ trust in online shopping.

‘Trustworthiness of the online shopping medium’ refers to the level of confidence consumers have with respect to the technical competence and performance level of the IT infrastructure, for example, computer system through which online purchases are transacted [2], [7]. The technical competence of a computer system involves its ability to correctly perform the required and intended tasks, and its performance level is measured by its speed, reliability and availability [7]. With the use of technically competent and high performance computing system, it is expected that the level of consumers’ trust in online shopping will increase and this expectation is supported by findings in [2].

‘Online shopping contextual factors’ deal with issues about Internet security and privacy in building trust between online sellers and consumers. In particular, several studies have looked at the effects of security and privacy assurances by third-party certifications have on the level of online consumers’ perceived risk and trust. Assurances provided by third-party certifications could appear as tangible cues or quality symbols on websites that exemplify the various legal or regulatory impositions put in place to ensure favorable conditions for successful e-commerce ([1], [8]) and may reinforce the trust relationship that has already been

established between the online vendors and their customers [6]. Hence, third-party security and privacy certification is expected to increase consumers’ level of trust in online shopping. However, this expectation is not supported by the findings in [7].

‘Other factors’ that may influence consumers’ trust in online shopping that are not included in the above three components include website design/infrastructure, size and reputation of online vendors. In B2C e-commerce, the vendor’s website is the main interaction channel through which the vendor maintains contact with its customers, hence the website quality, the layout, appeal and ease-of-use are possible factors that may play a role in influencing consumers’ trust ([1], [2], [5]). Quality websites help alleviate the perceived risks in online shopping and consequently it is expected that website quality will positively affect consumer trust in online shopping and this expectation is supported in [2]. Chen and Dillion indicate that “characteristics such as firm size, number of years that a firm has been in business, reputation, and brand recognition are considered important in influencing a customer’s trust towards an online vendor” [1], hence online vendors that are huge in size are perceived to have attained their size by having high level of commitments to safeguard its reputation and provide services to their customers and this will positively affect consumer trust in online shopping.

Another component of the trust model is ‘trust propensity’. Trust propensity is a personality trait [7] that represents a person’s consistent natural tendency to depend or rely on others on how much to trust in various situations. Consumers with high trust propensity generally regard others as good-natured and reliable, and believe that better outcomes could be achieved by treating others as though they had meant well. Hence, it is expected that trust propensity would have a moderating effect on the four components of the trust model and it is likely that the effect is a positive one.

III. Methodology

A survey with self-administered survey questionnaires was conducted to gather the necessary information for the study. The survey questionnaires were adapted mainly from [7] and [2] to suit the purposes of this study. The various constructs in the proposed trust model are measured using the 5-point Likert-type scale items.

A pilot study with 15 National University of Singapore students was first conducted to assess the clarity and accuracy of the survey questions. The questions were generally seen to be clear and unambiguous by the respondents and only minor modifications were done to the questionnaires. Subsequently, a street survey was conducted outside a major public transportation station. Every fifth person that passed by the station was approached and asked whether he or she has ever accessed the Internet before and only those who answered positively were requested to complete the questionnaires. A total of 208 responses were

obtained.

Based on the model we have adopted, the possible hypotheses are that the attributes of the four components of the trust model are expected to have positive effect on consumer trust (CT) in online shopping. That is, perceived ability (PA), perceived benevolence (PB), perceived integrity (PI) of the online merchant, technical competence (TC), performance level (PL) of the online shopping medium, third-party certification (TPC), website quality (WQ), size of online vendor (SZ) and reputation of online vendor (RP) would affect positively on consumers' trust in online shopping. Also, trust propensity (TP) is hypothesized to have a positive moderating effect on the relationship between all the abovementioned attributes and consumer trust in online shopping.

A regression model is used to assess the relationships between consumer trust in online shopping and the various attributes of the trust drivers:

$$CT = \beta_0 + \beta_1(PA) + \beta_2(PB) + \beta_3(PI) + \beta_4(TC) + \beta_5(PL) + \beta_6(TPC) + \beta_7(WQ) + \beta_8(SZ) + \beta_9(RP) + \varepsilon \quad (1)$$

where β_i is the regression coefficient that measures the effect of the i -th attribute on consumer trust and ε is the random error term.

A regression model is also used to assess the moderating effects of trust propensity of consumers could have on the relationship between each trust driver and consumer trust in online shopping. The average score of the two items used to assess trust propensity is used as a measure of the respondent's trust propensity. The moderating effect of trust propensity on each attribute of the trust drivers towards consumer trust is measured by the interaction between the attribute and trust propensity. The model used is as follows:

$$CT = \alpha_0 + \alpha_1(TPxPA) + \alpha_2(TPxPB) + \alpha_3(TPxPI) + \alpha_4(TPxTC) + \alpha_5(TPxPL) + \alpha_6(TPxTPC) + \alpha_7(TPxWQ) + \alpha_8(TPxSZ) + \alpha_9(TPxRP) + \varepsilon \quad (2)$$

where α_i measures the effect of trust propensity on the relationship between consumer's trust and the attributes of the trust drivers.

IV. Results

Altogether 208 responses were obtained, out of which 53% are males and 47% females. About two thirds of the respondents are above 21 years of age and about half of them have monthly allowance/income of \$1000 or less.

IV. 1 Relationship between Consumer Trust in Online Shopping and Trust Drivers

To assess the direct effects of the attributes of the trust drivers on consumer trust in online shopping, model (1) is used with the following results:

Table 1: Estimates of Effects of Attributes

Attribute	β_i	p-value
Ability	0.063	0.205
Benevolence	0.117	0.008*
Integrity	0.290	0.000*
Technical Competence	0.028	0.276
Performance Level	0.119	0.022*
Third-Party Certification	0.222	0.000*
Website Quality	0.475	0.000*
Online Vendor Size	0.049	0.091
Online Vendor Reputation	0.112	0.000*

* significant at 0.05 level

The overall model is significant ($p < 0.05$) and about 88% of the variation in the levels of consumer trust can be explained by the model. Inspection of the residual plots and the normal probability plot for the residuals does not reveal any serious violations of the usual assumptions of regression model.

As seen from table 1, two attributes of the trustworthiness of Internet merchant, perceived benevolence and integrity, have significant effects on consumer trust, while perceived ability does not have significant impact on consumer trust. These results are consistent with the findings of Lee and Turban [7].

As for the trustworthiness of online medium, the attribute performance level is found to have a positive effect on consumer trust and this is similar to the finding in Corbitt et al [2]. But, the effect of technical competence is found to be insignificant and this result is contrary to that found in [2]. This could be because of the different methodology employed as the sample used in [2] is a voluntary sample through invitation by emails.

Third-party certification is found to have a significant positive effect on consumer trust in online shopping and this result is not consistent with the findings of Lee and Turban [7]. Again, this could be because of the different methodology used as a convenience sample is used in [7]. The quality of website and the reputation of the online vendor are also found to have significant positive impact on consumer trust in online shopping while the size of online vendor does not have a significant impact.

IV. 2 Moderating Effects of Trust Propensity

Model (2) is used to assess the moderating effects of trust propensity on the relationship between the trust drivers and consumer trust. The results obtained are as follows:

Table 2: Moderating Effects of Trust Propensity

Interaction between Trust Propensity and Attribute	α_i	p-value
Ability	0.011	0.561
Benevolence	0.003	0.814
Integrity	0.008	0.000*
Technical Competence	-	0.295
Performance Level	0.009	0.616
	0.009	
Third-Party Certification	0.067	0.000*
Website Quality	0.073	0.000*
Online Vendor Size	0.003	0.760
Online Vendor Reputation	0.027	0.007*

* significant at 0.05 level

The model is again significant and about 84% of the variation in the level of consumer trust in online shopping can be explained by the interactions between trust propensity and the attributes of the trust drivers. There are also no serious violations of the usual assumptions on the model.

The trust propensity of consumers is found to have a significant positive moderating effect on the relationship between perceived integrity of online vendors and consumer trust and this is in line with the finding in [7]. While for the other two attributes of trustworthiness of online merchant, trust propensity does not seem to have any moderating effects on them.

The trust propensity of consumers is found to have no significant moderating effects on the relationship between consumer trust and both attributes of the trustworthiness of online medium. Contrary to Lee and Turban [7], we find that trust propensity does have a significant moderating effect on the relationship between third-party certification and consumer trust. For the other factors, trust propensity has significant moderating effect only on the relationship between website quality and reputation of online vendor and consumer trust.

V. Limitations

The random sample obtained for this study included those who have accessed the Internet before, but no distinction was made whether they have made any online purchases before. The perceptions of trust between these two groups are likely to be different and the effects of the trust drivers on consumer trust could also be different. Perhaps, the differences between these two groups could be investigated further when the base of actual online consumers becomes larger.

The limited scale items used in this study to represent some of the constructs of the trust model may not fully reflect the complexities of the constructs. For example, consumer trust and reputation of online vendors are each

measured with a 1-item instrument and this may not accurately reflect the true level of trust and reputation.

The proposed trust model does not include the consequences of trust. Since the consequences of trust are related to consequences of risk taking, as pointed out in Lee and Turban [7], an understanding of trust that does not examine its relationship with risk is incomplete.

VI. Conclusions

This paper uses the trust model of Lee and Turban [7] to study the relationship between consumer trust and the four trust drivers, namely, trustworthiness of Internet merchant, trustworthiness of online shopping medium, contextual factors and other factors in the Singapore context. Though some of our findings are different from that in [7] and also that of Corbitt et al [2], there are also a lot of similarities between our results. The differences could be because of the different methodologies used in drawing samples and it could also be due to the differences between the societies in terms of willingness to accept new technologies, technical knowhow and the sophistication of Internet infrastructures.

Some of the results obtained here can be used as guidelines to build trusting relationships between online merchants and consumers. For example, in marketing and advertising activities, size of online vendor and its technical competence need not be emphasized since they do not seem to have any effect on consumer trust, whereas the performance of the vendor, its commitment to customers and perception of security by third-party certification should be emphasized. Also, trust propensity seems to have some moderating effects on some the trust drivers, hence it might be beneficial for online merchants to provide spaces on their websites for consumers to post comments and ratings on their products and services.

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The Relationships among Trust, E-Satisfaction, E-Loyalty, and Customer Online Behaviors

Tzy-Wen Tang¹, Chung-Hung Tsai², Wen-Ping Wu³

¹ Department of Management School and Economic, University of Edinburgh, tangtzywen@yahoo.com.tw

² Department of Health Administration, Tzu Chi College of Technology

³ Department of Business Administration, Takming College

Abstract: Online shopping behaviors, different from traditional shopping behaviors, are related to information system and characterized with uncertainty, anonymity and potential opportunism. This paper is to conceptualize and analyze customer online behaviors, trust, customer satisfaction and customer loyalty based on Technology Acceptance Model (TAM). 1258 valid questionnaires are gathered from online customers having e-shopping experiences in Taiwan. Using structural equation modeling, the empirical results indicated that perceived use of use, perceived usefulness, and trust has the significant effects to facilitate customer satisfaction and customer loyalty, and further, effects customer's intentions and behaviors toward online purchasing.

Keywords: Technology Acceptance Model, Trust, Customer Behaviors, Customer Satisfaction, Customer Loyalty.

I. Introduction

Internet/WWW usage changes ways of doing business as well as the way we live. The number of people who use the Internet has increased dramatically and has exceeded the 1.4 billion in the 2003 [1]. The electronic commerce and Internet business market has grown rapidly, at an exponential rate, accompanying the increase in the number of Internet users. According to a recent study by the Pew Internet and American Life Project, the Internet has gone from novelty to utility for many users, and an increasing number of customers are spending more time shopping electronically for books, music, and airline tickets and so on [2]. This is supported by a U.S. Census Bureau report, by U.S. Department of Commerce, that B2C EC reached \$69 billion in 2004, as compared to \$15 billion in 1999 [3]. These online-shopping trends indicate a remarkable potential and an alternative to the traditional brick-and-mortar shopping.

However, research indicates that 80%-85% of those that browse Web sites for goods and services do not engage in online purchases [4] [5]. Additionally, while many web users are motivated to start an online purchase transaction, 75% of them discontinue the transaction or are termed abandoning their shopping cart [6]. This implies that web users are

identifying attractive shopping opportunities on the web, but there are barriers and other concerns preventing the purchase from being completed. Besides, despite the recent rapid growth in Internet user numbers, the penetration rate of online-shopping is still low. One of the most plausible reasons is a lack of consumers' trust [7].

Moreover, in the online environments, it is more difficult for company to build customer loyalty when consumers can leave with just a mouse click away [8]. Although customer increasing their interactions with company through websites, there are plenty online shops offering the same product or service, customer can easily switch their purchasing decision than they do in physical environment. For the companies, attracting new online customers will be more difficult and costly to retain existing ones [9], therefore, customer satisfaction and customer loyalty are another important issues in online retailing.

Technology Acceptance Model (TAM) is developed to explore a user behavior model when an individual is using an information system [10]. TAM is a mature model because it has been validated in widely information contexts. This study, based on TAM model, expands the application on online environment to analyze customer online behaviors.

Recently, there have been a number of researches investigating online customer satisfaction or the role of trust in the specific context of e-commerce. However, it still lack of the understanding about the relationships between trust, customer satisfaction, customer loyalty, and online consumer behaviors with theoretical base. The objective of this paper is to explore the factors affecting online purchase intentions in consumer markets. Elucidation of online consumer behaviors will benefit e-venders in their efforts to sell products or services online in the future.

II. Literature Review

II.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 [11]. 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) [11]. 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.

II. 2 Theory of Technology Acceptance Model

Technology Acceptance Model (TAM), developed by Davis in 1989, is one of the most influential research models in studies of the determinants of information systems/information technology (IS/IT) acceptance to predict the intention of use and acceptance of IS/IT by individuals. Based on TRA Model, TAM points out two particular beliefs—perceived ease of use (PEOU) and perceived usefulness (PU), to represent the antecedents of system usage in TAM. PEOU is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" and PU is defined as "the degree to which a person believes that using a particular system would be free of effort" [10]. In the TAM model, PEOU positively affects the PU. Moreover, PEOU and PU positively affect the attitude toward an information system, and further, positively affect individuals' intentions to use and accept of the information system.

Numerous empirical tests have indicated that TAM is a robust model of technology acceptance behaviors in wide variety of information systems and countries [12, 13, 14]. A website is, in essence, an information technology. As such, TAM is suitable to be applied in explaining online behavior. Accordingly, the following hypotheses were cast and tested:

- H1: A consumer's PEOU toward using online store positively affects his /her PU toward using the online store.
- H2: A consumer's PEOU toward using online store

positively affects his /her attitude toward using the online store.

- H3: A consumer's PU toward using online store positively affects his /her attitude toward using the online store.
- H4: A consumer's PU toward using online store positively affects his /her intention toward using the online store.
- H5: A consumer's attitude toward using online store positively affects his /her intention toward using the online store.
- H6: A consumer's intention toward using online store positively affects his /her behavior toward using the online store.

II. 3 Trust and Technology Acceptance Model

Trust has different definition in the various social science literatures such as sociology, social psychology, and organizational behavior. Trust, in a social psychological sense, is the belief that other people will react in predictable ways. In brief, trust is a belief that one can rely upon a promise made by another [16]. In the context of e-commerce, trust beliefs include the online consumers' beliefs and expectancies about trust-related characteristics of the online seller [17]. The online consumers desire the online sellers to be willing and able to act of the consumers' interests, to be honest in transactions (not divulging personal information to other vendors), and to be capable of delivering the ordered goods as promised.

Many trust studies in psychology and organizational behaviors focus on interpersonal relationships; other trust studies in economic and strategy field, on the other hand, focus on the inter-organization relationships. However, the analysis of trust in the context of electronic commerce should be considered as the relationship between firm and individual aspects. The technology itself—mainly the Internet—has to be considered as an object of trust [18]. As a result, online shop also could be considered as an object of trust.

TAM has been considered a robust framework to investigate how users develop attitudes towards technology and when they decide to utilize it [10, 19, 20, 21]. Several studies have applied TAM and trust in their models. Based on the previous literatures, trust is a mixed belief-intention variable in trust studies. However, when trust is integrated into TAM, the trusting intention is replaced by the intention variable of TAM. In other words, trust in TAM is trusting belief, reflecting the online consumer wants the online sellers to be willing and able to act matching the consumers' interests, to be honest in transactions (and not divulge personal information to other vendors), and to be capable of delivering the offered goods as promised.

There are several studies have investigated trust based on TAM [13, 16, 24, 25]. After the literature review on customers' online trust and TAM model, we decided to integrate "trust" into our expanded TAM model. In order to focus on the relationships among trust and TAM concepts, we examine these studies again within the TAM framework.

Koufaris and Hampton-Sosa [23] and Pavlou [16]

suggested that customers' PEOU and PU of the website have positive effects on trust of e-vendor. These authors believe trust could reduce the need for consumers to understand, monitor, and control the situation and facilitate transaction and make it effortless. In the e-commerce context, trust would reduce the consumer's need to monitor the vendor's actions and check every detail, which make on-line transactions easier. Accordingly, the following hypotheses were tested in this study:

- H7: A consumer's PEOU toward using online store positively affects his /her trust U toward using the online store.
- H8: A consumer's PU toward using online store positively affects his /her trust U toward using the online store.

Most studies indicated that trust plays a significant role in determining a customer's actions regarding that company. Empirical research has shown that trust increases customer intention to purchase a product from a company [22] as well as intention to return to that company [26]. Some research indicated that customer trust (a belief) influences customer attitude. Based on the TAM, we believed trust affects attitude directly and trust also affects intention indirectly through attitude.

- H9: A consumer's trust toward using online store positively affects his /her attitude toward using the online store.
- H10: A consumer's trust toward using online store positively affects his /her intention toward using the online store.

II. 4 Customer Satisfaction and Customer Loyalty in Virtual Environment

There are many studies investigated customer satisfaction in physical environment. With the rapid growth of e-commerce, researchers and managers are now interested at customer satisfaction in online settings. There are two theoretical perspectives related to satisfaction when customer online shopping. One is customer satisfaction from marketing perspectives, and the other one is user satisfaction about information system from information technology studies

In the marketing perspective, customer satisfaction is an individual's subjectively derived favorable evaluation about his or her consuming experiences. Customer's experiences of purchasing involves with several processes: need arousal, information search, alternatives evaluation, purchase decision, and post-purchase behavior [27]. Although consumer behavior in e-commerce contexts is essentially the same as any other consumer behavior, there are certain technology related features that play a part in consumer decision making [28]. For example, in the online environment, Internet offers online user several benefits about information-search stage by reducing the search cost and increasing shopping convenience and the richness of information. However, in the evaluating and ordering stages,

customers lack for physical checking and they have the security problem when they purchase online. It implied the customer experience of online shopping is much different to traditional way. Because online shopping is an interaction between marketing and technological characteristics, customer satisfaction in e-commerce context is more complicated than physical environment.

Otherwise, technology information studies focused on the end-user satisfaction from information system (IS) using prospective. User satisfaction is considered a significant factor in measuring IS success and IS use [29, 30, 31, 32]. Empirical studies indicated the more satisfied users are, the more successful the IS facilitate is. Moller and Licker [33] applied IS success model to investigate the e-commerce system success and they indicated that the user satisfaction toward e-commerce system is one of the determinants to e-commerce system successes.

In the e-commerce contexts, customer satisfaction toward online shopping is composed of customer satisfaction in purchasing process and user satisfaction in using information system (in this case, information system means website). We merge marketing perspective and IS perspective about satisfaction as "E-satisfaction" to explore the customer satisfaction when they shopping online. In this research, E-satisfaction is defined as the customer's pleasurable fulfillment about his or her prior online experience (including browsing experience and purchasing experience) with a given electronic commerce website.

Satisfaction is usually defined as to customer favorable or unfavorable feeling about the prior experience in marketing literature. Operationally, satisfaction is an attitudinal variable, because satisfaction represents favorable or unfavorable feeling which is related to judgments. Clarke [34] also indicated that satisfaction is an attitude to determine future behavior based on the analysis of the service-buying process. She stated that there is an evidence of a robust result that customer satisfaction is an attitudinal variable. In TRA and TAM's belief-attitude-intention-behavior model, attitude is measured by the person's favorable or unfavorable feeling about performing the behavior. Adamson and Shine [35] also indicated that TAM could be used to explore use satisfaction. Therefore, we believe customer E-satisfaction is a facet of attitude to predict customer's intention and behavior toward using website and we integrate customer E-satisfaction as an attitudinal variable into customer online behavior model based on TAM framework.

- H11 : PEOU toward using at online store positively affects E-satisfaction.
- H12: PU toward using at online store positively affects E-satisfaction.
- H13 : Trust toward website will positively affect E-satisfaction in the using behavior model.
- H14: E-satisfaction will positively affect intention toward using the online store.
- H15: E-satisfaction will positively affect behavior

toward using the online store.

While the importance of customer has been mentioned in the marketing literature, the conceptualization and empirical validation of customer loyalty in e-commerce context has seldom been addressed [36]. In the online environments, it is more difficult for company to build customer loyalty when consumers can leave with just a mouse click away [8]. There are plenty online shops offering the same product or service, customer can easily switch their purchasing decision than they do in physical environment. On the other hand, e-vendor can create more profit than before, because customer increasing their interactions with company through websites. According to Griffin [37], "one of the most exciting and successful uses of this revolutionary technology may be the Internet's role in building customer loyalty and maximizing sales to your existing customers." In increasingly competitive markets, being able to build consumers loyalty become the key factor in winning market share and developing sustainable competitive advantage [36]. In this study, "E-loyalty" is used in order to highlight the role of loyalty in e-commerce contexts when customer shopping online.

For lacks of consistent psychological meanings of loyalty, Oliver [38] purposed four stages of loyal formulation: cognitive sense first, then later in an affective sense, still latter in a conative manner, and finally in a behavioral manner.

We found that Oliver's model represents the similar concepts of TAM. Both of Oliver's model and TAM believe cognitive (belief) first, then later in affective (attitude), still latter in a conative manner (intention), and finally in action (behavior). However, in Oliver's model, the definition in cognitive dimension is far away from the definition of loyalty in marketing literature. Besides, behavior dimension of loyalty in Oliver's model is basically reflective behavior concept in TAM. Therefore, the behavior dimension of loyalty could be replaced by the "actual behavior" in TAM. In Oliver's models, only the affective dimension and conative dimension match the definition of loyalty in marketing studies. Therefore, we purpose that loyalty is an attitudinal-intentional variable, involving in feeling and linking to purchase intention.

H16: E-satisfaction will positively affect E-loyalty in the using behavior model.

H17 : Attitude toward using at online store positively affects E-loyalty.

H18: E-loyalty will have a positively effect on intention toward using the online store.

H19: E-loyalty will positively affect behavior toward using the online store.

III. Research Methods

III.1 Research Model

The relationships among trust, E-satisfaction, and E-loyalty towards other TAM constructs in this study are drawn as

Figure 1. In the Figure 1, there are three belief variables (PEOU, PU, and Trust), two attitudinal variables (attitude towards using the online shop and E-satisfaction), an attitudinal-intentional variable (E-loyalty). All of these constructs have directly or indirectly effects on customer intention and actual behavior toward using the online shop. Based on the literature review, E-satisfaction has three determinants: PEOU, PU and Trust. E-satisfaction also has three consequences: E-loyalty, intention toward using the online shops, and the actual usage. Additionally, E-loyalty plays as a mediator variable between two attitudinal variables, intention variable and behavior variables.

III.2 Measurement

These scales were established based on the reliability and validity of the TAM measures. Items of attitude toward purchasing online were modified from Suh and Han [24], Chau and Hu [20], in studies of consumer acceptance of electronic commerce. Items of purchase intention were adopted from Geffen and Straub [13,14] on their study of consumer behavior in B2C e-services. The scale of actual purchase behavior was captured with a standard item measuring on-line shopping frequency by Pavlou [16]. In addition, rather than devising a new scale for the dependent variable, this convention makes it possible to measure the dependent variable with extant scales that have been proven in measurement properties. Measures for trust are adapted primarily from Bhattacharjee [39], Suh and Han [24], and Pavlou [40]. The measurement items from the studies were collected and items with the same meaning were merged. Items of E-satisfaction and E-loyalty are adopted from Anderson and Srinivasan (2003) on exploring the relationship between E-satisfaction and E-loyalty. The items of E-satisfaction and E-loyalty, adopted from Anderson and Srinivasan [41], were based on the scale of customer satisfaction by Oliver [38] or Grewler [42]. All the items were measured on a seven-point scale ranging from strongly disagree (1) through neutral (4) to strongly agree (7). The higher values indicate higher degree of attitude, intention or actual purchasing online.

III.3 Sample

With purposive sampling method, a total of 3360 questionnaires were distributed through the 120 Executive MBA students and 4 lecturers of National Dong Hwa University in Taiwan. 2035 questionnaires were returned. We set a critical standard to define the "valid questionnaire". A questionnaire having more than 10 items clicked continually in the same score was considered to be invalid. Although the critical standard reduced the number of questioners, it could improve the quality of valid questionnaires. As a result, 88 were eliminated for conflicting and incompleteness and 689 respondents claimed they have never bought online. Eventually, 1258 valid questionnaires were collected. The net response rate is 37.8%. With descriptive statistic analysis, there was a relatively even split between males (46%) and females

(54%) respondents. The majority of respondents age from 21-35 years old representing 69% of the whole responses. In terms of occupation, the respondents reveal a quite even distribution: student (19%), service trades (20%), finance (15%), government/military (14%), business (12 %) and industries (9%).

Table 1 presented the results of factor analysis and alpha coefficients for each construct with reliability analysis. The

result of reliability analysis is shown as Table 1. Conbach's alpha values of each construct are from 0.71 to 0.90, indicating a level above the 0.70, the threshold recommended by Nunnally [44]. Most of them are even above the 0.8. Additionally, the variance extracted values are from 53% to 69%, exceeding 50%. It reveals that the scale of trust exhibits strong internal reliability.

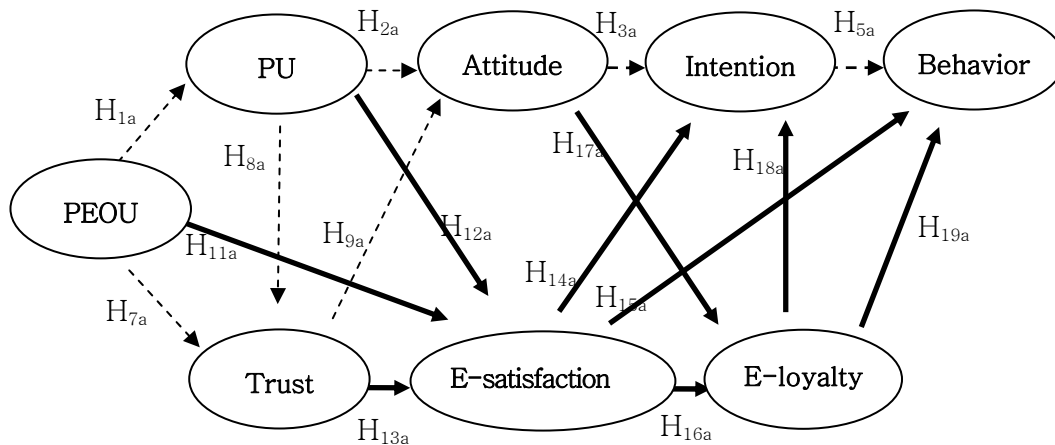


Figure 1 The Relationships among Trust, E-satisfaction, E-loyalty, and Customer Online Behaviors

Table 1 The Result of Reliability Analysis

	Number of Items	Variance Extracted	Scale Reliability (alpha)
Perceived ease of use (PEOU)	6	61.20%	0.87
Perceived usefulness (PU)	6	63.29%	0.88
Attitude	6	65.68%	0.89
Behavior Intention	5	65.91%	0.87
Usage(Actual Using Behavior)	4	53.19%	0.71
Trust	6	69.28%	0.90
E-Satisfaction	7	63.15%	0.90
E-Loyalty	6	61.31%	0.84

IV. Results and Discussion

After assessing the reliability and validity of measurement model, we tested the hypothesis and overall fit of the path model by using the maximum likelihood (ML) technique to estimate the parameters. The scale for each factor was set by fixing the factor loading to one of the indicators (items). The path coefficients and overall model fit indices of research model are drawn as Table 2 and Figure 2.

Table 2 Structural Equation Model Analysis

Hypothesis	Constructs	Coefficients
		s

	From	To	
H ₁	PEOU	→	PU
H ₂	PEOU	→	Attitude
H ₃	PU	→	Attitude
H ₄	PU	→	Intention

Table 2 Structural Equation Model Analysis (continuously)

Hypothesis	Constructs			Coefficients
	From		To	
H ₅	Attitude	→	Intention	0.65***
H ₆	Intention	→	Behavior	0.73***
H ₉	Trust	→	Attitude	0.53***
H ₁₀	Trust	→	Intention	0.32**
H ₁₁	PEOU	→	E-satisfaction	0.04
H ₁₂	PU	→	E-satisfaction	0.26**
H ₁₃	Trust	→	E-satisfaction	0.65***
H ₁₄	E-satisfaction	→	Intention	0.08
H ₁₅	E-satisfaction	→	Behavior	0.12
H ₁₆	E-satisfaction	→	E-loyalty	0.38***
H ₁₇	Attitude	→	E-loyalty	0.52***
H ₁₈	E-loyalty	→	Intention	0.23**
H ₁₉	E-loyalty	→	Behavior	0.18*

* P<0.05

** P<0.01

*** P<0.001

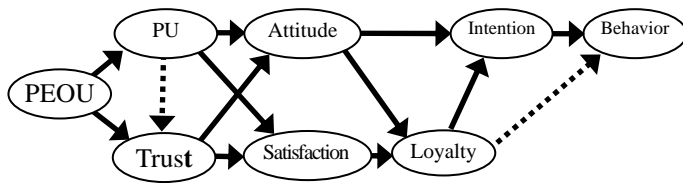


Figure 2 The Role of Trust, E-Satisfaction and E-Loyalty based on Technology Acceptance Model

V. Conclusions and Limitation

V.1 Conclusions

With the empirical results, the path coefficients of PEOU to PU (H1), PU to attitude (H3), attitude to behavioral Intention (H5), behavior intention to behavior (H6) are significant at the 0.001 significance. In other words, H1, H3, H5, and H6 are supportive. However, the effects from PEOU to attitude (H2) and PU to intention (H4) are not significant. It implies that there is a linear causal relationship among PEOU-PU-attitude-behavioral intention-behavior.

The purpose of this study was to explore the role of trust in the mechanism of online shopping. We hypothesized that trust is the consequence of PEOU and PU, and trust is also the antecedent of attitude and intention. The empirical results indicate that trust played similar roles as PU because it is the consequence of PEOU and the antecedent of attitude. As in previous researches, consumer trust, as PU, led to increase the using intention [13,14]. However, trust does not influence intention directly. Trust affects intention through the attitude mediator variable. Besides, trust might affect PU, but this is not supported in all online behavior models.

It is note worthy that consumer trust has a stronger effect on attitude than PU does. It corresponds to the result of Gefen and Straub [13, 14]. It implies that online shopping service depends not only on the operational characteristics of websites, its PU and PEOU, but also, and possible to a greater degree on consumer trust toward the websites. Therefore, managers need to take this into account in their website planning efforts. Furthermore, with the empirical results, it indicated that E-satisfaction was only affected by PU and Trust and E-satisfaction only affected E-loyalty. Although E-satisfaction not affects Behavior directly, it might affect Behavior through E-loyalty and Intention.

In the TAM model integrated Trust, E-satisfaction and E-Loyalty; there are three belief variables (PEOU, PU and Trust), three attitude variables (Attitude, E-satisfaction and E-loyalty), one intention variable, and one behavior variable. Belief variables positively affect Attitude toward website, and further, positively affect the individual's intention to use (including browse and purchase), finally affect the individual's actual using behavior. In addition, in three belief variables, PEOU was the antecedent of PU and Trust, and PU also had influence on Trust. Although PEOU was belief variable, it not affect other attitude variables directly, but

affect other attitude variables through PU and Trust. In three attitude variables, both Attitude and E-satisfaction were affected by PU and Trust, and affected E-loyalty. The Intention affected by Attitude and E-loyalty. The Behavior was affected chiefly by Intention and secondarily by E-loyalty. In briefly, Trust played the similar role as PU; E-satisfaction played the similar role as Attitude; and E-loyalty was the consequence of E-satisfaction/Attitude and the antecedent of Intention.

In the original TAM, Attitude was merely affect by PEOU and PU. However, we found Trust has had a stronger effect on Attitude than PEOU and PU did. The effect from PEOU to Attitude was even not significant in our models. It indicated trust was the most major belief factor to influence customer online behavior. Trust also the chief factor to affect E-satisfaction.

V.2 Following Research and Suggestion

The sample in this study consisted of 1258 online customer having e-shopping experienced from various occupation (Student=19%, Service trades=20%, Financial =15%, Government/ Military=14%, Business=12% , Industry=9%), various age group (under 20 =11%, 21-25 group=23%, 26-30 group= 26.1%, 31-35 groups= 20%, 36-40 groups=11%, above 41= 8%, various websites, split of male (46%)and female (54%). It demonstrated the generalizability in our study and our results can generalizable to various types of customers and websites.

TAM is a mature model and has been validated in different contexts. Because Internet is a kind of technology, it is proper to applied TAM to explore the user (customer) behavior online. However, this is not without limitation. Because this is the first study to divide using behavior to browsing behavior and purchasing behavior, the validity of scales to measure each construct might be need to be confirmed for further studies. For examples, the reliability and validity of behavior construct didn't not perform as well as other constructs. It was resulted from the items measuring behavior were not measured on a seven-point scale. Not like the other perceived constructs could be measured with seven-point scale, the frequency and amount of browsing and purchasing were not proper to adopted seven-point scale and resulted in lower reliability and validity and it might further affect the results of research models. We hoped that further studied provide more guideline about this for web-based companies who are looking to improve their customer based and sales.

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The Webquality Analyser: Benchmarking Industry Websites

John Hamilton *, Roy Wybrow**

* James Cook University, Cairns, Australia 4870
John.Hamilton@jcu.edu.au

** James Cook University, Cairns, Australia 4870
Roy.Wybrow@jcu.edu.au

Abstract: The structure and layout of various websites across a wide spectrum of service industries was analysed using the WebQuality Analyser (WQA). The WQA incorporated forty five critical success elements delivered by quality on-line websites. These success elements covered information technology (IT) and marketing-services related sectors, and were further divided into five key drivers encapsulating each sector. Each sector driver was then divided into four or five customer-enabler features (covering structure and function), each with several feature components. A present / absent approach determined each component. A seven-point, Likert scale encapsulated the relative presence of the features of each driver.

Although it houses both measurable and subjective components, the WQA offers a useful means to compare relevant websites, and to understand the differences with respect to one's competitors.

Further investigation of the specific on-line driver ratings demonstrated where key competitive advantage may reside. This benchmarking tool defined website strengths and weaknesses thereby allowing for corrections to the website structure of the specific business. This paper introduces the WQA, and reports on the marketing-services sector of this new benchmarking tool.

Keywords: Service Operations on the Web; benchmarking; website; analysis; service value networks; analysis; compare.

I. Introduction

Benchmarking delivers a "comparison of a company's performance in certain areas with that of other firms in its industry and / or with those firms that are identified as world class competition in specific functions and operations" [1]. It can also cut across traditional lines, providing opportunities for new and innovative ways to increase performance, and be a "search for industry best practices that lead to superior performance" [2][3]. Modern benchmarking was initiated by Xerox. They modelled their spare parts distribution on the warehousing and distribution practices of L.L. Bean. Since then Xerox has continued to promote best practices. In 2000 the American Productivity & Quality Center recognised Xerox's development of 'proactive strategies to identify, retain, and re-use knowledge so that individual expertise is

transformed into real working knowledge.'

Benchmarking, best practice, and reengineering are key pathways to achieving dramatic improvement in critical contemporary areas such as cost, quality, service and speed [4]. Reengineering often involves the disruptive [5] reinventing of processes and / or the substantial redesign of existing procedures, and is not merely the delivery of continuous incremental changes. Reengineering without benchmarking will generally deliver smaller improvements than reengineering with benchmarking [6]. By studying other best practice operations, companies may identify, and import new technologies, skills, structures, training and capabilities [7]. Hence, including these identified best practices may then deliver new competitive advantages [8][9].

Today firms routinely share best practice and benchmarking information, and often seek help from one another to achieve higher quality and better performance. At times they may even jointly market their services to customers or even work closely with their competitors. The Cairns Super-Yacht Cluster [10] now houses over forty local businesses who previously competed with each in the fishing, large marine taxi, and tourist related marine activity sectors. These former competitors collaboratively use their world-class facilities, competitive technologies, and specialist best practice skills to repair, maintain and refit foreign registered super-yachts. They have created a world-class, dynamically benchmarked, business block that in 2004 generated an economic impact of over \$40M. This industry has technologically reengineered into a best-in-world super-yacht re-builder.

II. Benchmarking and the Web

Benchmarking, best practice and reengineering also apply to virtual businesses or Internet- based website businesses, and also to those physical businesses incorporating internet-based websites into their business models. Evans [5] suggests that if the entire value chain (including devices, networks, standards, and applications) is handled correctly on the supply side and combined as an e-business, new opportunities for both business agility and competitive value may be extracted. In addition, Evans [5] considers the business's customer-driven demand side with its cost reductions, revenue generation, customer satisfaction, increased productivity, reduced cycle times, speed and flexibility and suggests these functions may be reconfigured to drive innovative use of technologies. He suggests these

attributes, once benchmarked, and assessed, may allow mechanisms that allow the business to differentiate itself from its competitors.

Benchmarking and competitive intelligence gathering activities are necessary website marketing activities. [11] Competitive intelligence delivers a collage of information about selected competitors. This gathered information is then applied to short and long term strategic planning to facilitate better and smarter business decisions [12]. Competitive intelligence involves data collection and storage, data analysis and interpretation, and the dissemination of intelligence. The process is information-based, systematic, and delivers 'actionable information' [13]. Thus a tool to analyse relative website competitiveness will likely be an important aspect of a business's competitive intelligence.

In addition to marketing considerations, latest advances in website-related technologies such as Microsoft Research's 3D TaskGalley [14] offer new ways to present information, and to maximise the quality of information conveyed whilst minimizing the effort applied by the end user. This technology enhancement also impacts on website marketing functions [16]. Microsoft's 3D smart visual website interfaces present more information. This 3D space or room, with information objects arranged on the floor, ceiling and walls, moves the most important information to the front, and the least important information to the back. Hence, the productivity of the website may be enhanced.

Considering web-based business–customer encounters, the bundling of products and services has become another important trend to add value and drive sales. These encounter areas are best delivered via a three pronged approach that incorporates the areas of: marketing, services, and technological application [15][16]. Website visitations, unlike physical business contact times are generally of very short duration, and so require a quick focussing of customer intent. However other advantages remain, these include – open for business 24/7/365 with continuous revenue generation possibilities and ease of modification to on-line 'shopfront', products and services. Lists of website features have been compiled [17], with over 460 features being displayed in one list. Some of these features constitute customer-related 'benchmarkable' areas [18].

Many researchers have investigated various aspects of website benchmarking. Van der Wiele & Brown, [19] focused on information content analysis based on the traditional 4P's (product, price, place, promotion and other website information not fitting the above four categories. Scoring used Whiteley's [20][21] method assigning '0' to indicate absence of a feature's components, or '1' to indicate presence of a component of a feature. This method lends neatly to development of a computerised solution. On rare occasions a subjective decision concerning a component may be required. In this situation a conglomeration of items may blur the decision as to whether a component is rated present or absent.

Today websites are evaluated using a variety of methods including 'web assessment models' [20][21][22]; QFD,

'feature assessment analysis' [23]; 'strategic positioning' [24][25]; 'customer interface marketing design elements' [26]; 'industry-wide comparisons' [16]; 'objective feature presence' [23][28, and various benchmarking systems'. Barton [29] use 0-10 point scales to scale their identified features and analyse these via Ho's [30] customer perception of value added benefits, and via their own Five Quadrants Evaluation Model. Still others use benchmarking teams and Baldrige criteria to evaluate websites [31], but even these measures have not accurately reflected comparisons between websites, especially from an IT services and marketing approach [16].

This paper compiles the combinations of the above research with that of website details [32](w3C.com); hexagonal comparison grid [33]; service value networks [16]; and a 100 point measurement tool (worldsbest website.com) to develop a new model for benchmarking and rating websites. This Web Quality Analyser (WQA) was initially tested on the on-line (or e-business) real estate industry. Subsequently, additional testing indicated it had more general application and the WQA may be applied across the gambit of on-line business ventures. It was also tested against small sole-operator businesses, medium sized operations and through to large portal-sized ventures.

III. Website Marketing Drivers and Component Features

The key structure and function feature components used in assessing the weighting of the five features for each driver within the website information technology sector of services industry are presented under the driver blocks of: functionality, design, content, originality and effectiveness. The drivers for the website marketing-services sector are: company product presence, value adding services, target market, searchability and creative expression. These components and features of the five marketing-services WQA drivers are each discussed next.

III. 1 Company – Product Presence

Product Representation: here products / services are faithfully described; 'sold' to the user as quality items; quality-badged; accurately costed [18] [35][78][79][80].

Product Information: is accurate and concise; linked to databases; linked to additional user information; capable of showing alternative products / services [25][63].

Company Representation: shows the company as modern and professional business [18][80][81].

Company Information: presents relevant company information; accreditations; contacts; 'About Us' [40] [80] [81].

III. 2 Value Adding Services

Value Added Links: cover links to internal or external added-value sites e.g. lending facilities, financial institutions, removalists, etc; are responsive to user demands; cover internal SC members and external peripheral partners)

The above twenty key website features (representing the five marketing-services drivers) and their components were systematically investigated across 130 service industry

The WQA assesses websites using five information technology design drivers – functionality, design, content, originality, and professionalism / effectiveness. These structures offer a position-promotion vehicle for the website. The WQA also incorporates five marketing-services related drivers – company product presence, additional services, target market, searchability, and creative expression. These

relate to the product and / or service, and how the website should be moulded. This paper assesses the marketing-services related drivers of the WQA.

A standard data-collection criterion was used [89]. A multidimensional scaling technique drawing on the combination of subjective (or perception), objective (or measurable), and respondent feature preference (idea patterns) rating scales allowed the comparison of individual business websites [90]. A present ('1') or absent ('0') rating scale similar to those used by Whiteley and Everett [21][23] was used at the feature component level, and was then converted to a feature Likert measure. The traditional seven point 'more' or 'less' Likert scale was adopted as the prime scaling measure for each feature. This summated rating scale actually measured multiple questions in one, with the numeric score reflecting the degree of attitudinal or measurable 'favourableness'.

The ten website drivers – five IT, and five marketing-services related drivers (or factors), presented forty five Likert scale features (indicator variables). Each four or five features influence each driver.

The forty five dataset features (indicator variables representing their respective components) measured, easily met all reliability criteria. These features were then used to compile comparison datasets. The business's ability to deliver desired effects (when compared to its competitors) was thus measurable. Feature presence (or absence) was either measured, or estimated. Individual differences were controlled using a sufficiently large dataset, and a relative effectiveness scale could be produced from the dataset.

Trials with tertiary student groups (across first, third and MBA levels) were conducted over 2003 and 2004. Typically, final year undergraduate student groups, averaged 30 persons per class per location, Students from Sydney, Melbourne, Townsville and Cairns, Singapore and Malaysia participated. These trials delivered a successful website ratings model called the Web Quality Analyser (WQA). This paper reports on the 2005 study, and only considers the marketing-services components of the WQA.

In 2005 the WQA was tested in the business community across Australia. Twenty eight, IT-skilled, data-collectors each rated websites similarly. In addition sixty five marketing persons across Australia tested the marketability drivers. Again feature classifications were rated similarly.

IV.1 Sample

The sample size consisted of 126 service industry websites. In order to avoid possible bias firms selected were drawn from across the services industry. These included: financial services (3%), hospitality (14%), logistical transportation - including airlines (30%), Real Estate (24%), recruitment and careers (10%), legal services (10%), and tourism (10%). Within these sectors a spectrum of large, medium and small firms were selected. In addition multiple testing of certain areas was conducted to ensure consistency of results.

Predominant businesses were of micro and small to medium size, with approximately 18% fitting the major or

global corporation's category. This approximates with the Australian Bureau of Statistics 2004 data where 79% of businesses are small to medium sized industries, and is in accordance with the Australian services industry mix, and implies that the sampling error is low at around +/- 5% for the overall sample.

IV.2 Dimensionality

Here a large range of components, features and drivers have been identified. Figure 1 summarises the factorial models for each of the five marketing-service sector drivers. As can be seen from this diagram all features (competencies) are considered first order factors.

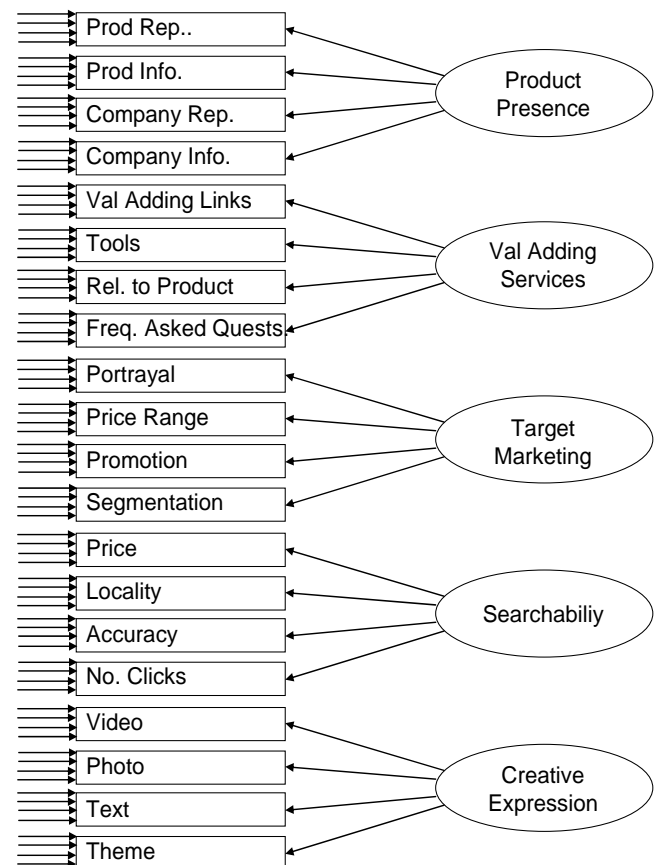


Figure 1: Factorial Model: WQA Marketing-Services Sector

Considering this model and the uniqueness of each service sector driver, a confirmatory factor analysis (CFA) was conducted and an estimation of the model was theoretically deduced from each scale.

Dimensionality of the tool was tested utilising factor analysis using Varimax rotation across all twenty indicators (termed features, and listed in section 3.6. to 3.10 above) to reduce these indicator variables into the predicted model five factor areas. Factor analysis tested appropriateness of the indicators divisions into the selected driver groups as used in the WQA. The Kaiser-Meyer-Olkin measure of sampling adequacy yielded a value of greater than 0.6, being 0.894,

with Bartlett's tests for sphericity at 0.000, being highly significant, (with 190 degrees of freedom). Thus indicating factor analysis was deemed appropriate. Using the Varimax rotation method with Kaiser normalisation factors a convergence to the five marketing-services sector driver factors of the WQA were reached after only six iterations of rotation.

Table 1: Varimax Factor Loadings: WQA Marketing-Services Sector

Driver (Factor)	Initial Eigen-values			Extraction Sums of Squared Values			Rotation Sums of Squared Values		
	Total	% of Var.	Cum. %	Total	% of Var.	Cum. %	Total	% of Var.	Cum. %
Presence	10.413	41.653	41.653	10.413	41.653	41.653	6.220	24.879	24.879
Val	2.680	10.722	52.374	2.680	10.722	52.374	3.676	14.704	39.582
Searchability	2.110	8.440	60.815	2.110	8.440	60.815	3.570	14.281	53.863
Market	1.743	6.970	67.785	1.743	6.970	67.785	2.702	10.870	64.670
Creativity	1.400	5.603	73.386	1.400	5.602	73.386	2.176	8.716	73.386

Principal factor analysis conducted on the five drivers, yielded all drivers with eigenvalues above 1.0. After Varimax rotation, the first driver (factor) - 'Product Company Presence', reflected that all four features (indicator variables) loaded highly. Similar trends applied to the other marketing-services drivers, albeit at slightly lower levels. The five Varimax drivers (factors) ranged from 24.9% to 8.7% of total variance, and accounted for 73.4% of the total variance. The five factors were subjected to a comparison analysis with eigenvalues calculated using the Montocarlo PCA – Parallel Analysis. All five drivers (factors) chosen had eigenvalues greater than their comparable Montocarlo compatriates, and were therefore retained.

Table 2: Montocarlo PCA Parallel Analysis: WQA Marketing-Services Sector

Number of variables		20
Number of subjects		200
Number of replications		50
Eigenvalue	Random Eigenvalue	Standard Deviation
1	1.6046	0.0744
2	1.4861	0.0432
3	1.3997	0.0407
4	1.3241	0.0258
5	1.2659	0.0278
6	1.2035	0.0286
7	1.1532	0.0256

Montocarlo PCA – Parallel Analysis

Table 3: Varimax Factor Loadings: WQA Marketing-Services Sector

Driver (Factor)	Initial Eigen-values			Extraction Sums of Squared Values			Rotation Sums of Squared Values		
	Total	% of Var.	Cum. %	Total	% of Var.	Cum. %	Total	% of Var.	Cum. %
Presence	10.413	41.653	41.653	10.413	41.653	41.653	6.220	24.879	24.879
Val	2.680	10.722	52.374	2.680	10.722	52.374	3.676	14.704	39.582
Searchability	2.110	8.440	60.815	2.110	8.440	60.815	3.570	14.281	53.863
Market	1.743	6.970	67.785	1.743	6.970	67.785	2.702	10.870	64.670
Creativity	1.400	5.603	73.386	1.400	5.602	73.386	2.176	8.716	73.386

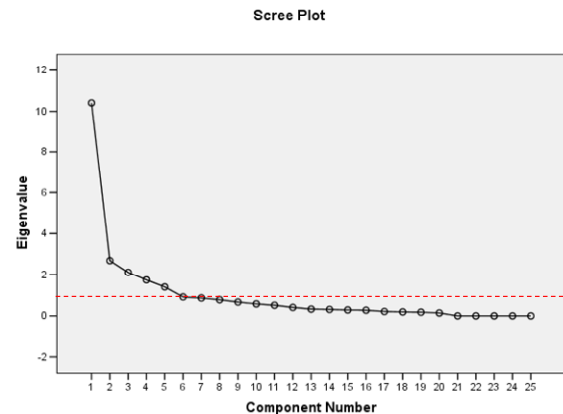


Figure 2: Factor Analysis Varimax Rotation: WQA Marketing-Services Sector

Table 3 and Figure 2 summarise the Rotated Component (Factor) Matrix five driver (factor) outcomes which map the WebQuality Analyser tool.

Table 4 and Figure 3 display a further factor analysis to ensure a more concrete factored model. This Oblique rotation, accounts for any non-orthogonal mapping of factors. Again a high degree of variance is explained by the first five factor components eigenvalues, which explain 68.1% of the total variance.

Table 4: Oblique Factor Loadings: WQA Marketing-Services Sector

Component	Initial Eigen-values			Extraction Sums of Squared Values			Rotation Total
	Total	% of Var.	Cum. %	Total	% of Var.	Cum. %	
Presence	7.421	37.107	37.107	10.413	41.653	37.107	6.094
Searchability	2.100	10.502	47.609	2.680	10.722	47.609	3.806
Value Adding	1.674	8.369	55.978	2.110	8.440	55.978	3.486
Market	1.304	6.519	62.498	1.743	6.970	62.498	1.900
Creativity	1.121	5.603	68.100	1.400	5.602	68.100	2.631

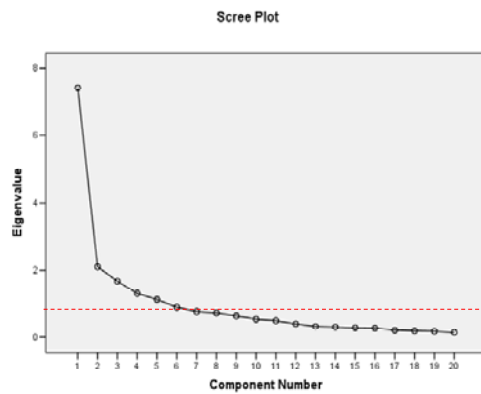


Figure 3: Factor Analysis Oblique Rotation

IV. 3 WQA Marketing-Services Sector

The resulting Pattern and Structure matrices, are displayed in Tables 5 and 6. These matrices were constructed after rotational convergence of nine iterations which strengthened the factors originally computed via the Varimax rotations, the Oblique methods thereby displaying a strong inter-correlation between the factors.

The ‘goodness-of-fit’ over each of the twenty features (indicator variables), as well as across each indicator variable comprising the five factors. Goodness-of-fit was calculated using Pearson’s and Deviance Chi-Square under multi-regression analysis. This resulted in a solid significance of 1.000 for each driver (factor) model. Thus, each marketing-services driver was deemed unidimensional, and driver measurement supports its distinctiveness against the other marketing-services drivers.

Principal Component Analysis; Oblique Rotation with Kaiser Normalisation; Rotation Convergence: 9 iterations.

IV. 4 Reliability Analysis

Individual reliability testing using Chronbach’s alpha indicated equal to or greater than 0.5, while composite testing indicated equal to or greater than 0.7. Further testing was achieved utilising Friedman’s ANOVA Test (between groups). Here, a large significance of greater than 0.2 showed no difference between the indicators of the services sector driver group. In addition a significance of equal to or greater than 0.05 signified a difference between the indicators of differing services sector driver groups. The entire twenty indicator set provided a composite Chronbach’s Alpha of 0.905, and a Friedman’s In-Between ANOVA of 0.000, thus indicating significant differences between all groups.

IV. 5 Content Validity & Convergent Validity

Content validity was grounded in the literature, with all indicators (features) of the measurement considered covered across all important aspects of the latent variable (driver) to be measured. In addition extensive pre-testing enabled scales suitable for this research.

Table 5: Oblique Pattern Matrix Factor Loadings: WQA Marketing-Services Sector

	Component				
	Presence	Searchability	Value Adding	Marketing	Creativity
Co. Representation	0.864				
Prod. Representation	0.850				
Product Info.	0.773				
Company Info.	0.624				
Location		0.890			
Accuracy		0.846			
Clicks		0.674			
Price		0.639			
Links			0.809		
Relevance			0.794		
Tools			0.775		
FAQ			0.532		
Portrayal				0.844	
Segmentation				0.720	
Price Range				-0.775	
Promotion				-0.622	
Video					0.842
Theme					0.800
Text					0.712
Photo					0.561

Convergent validity correlated the various indicator measurements (features) required to evaluate the latent variables (driver) to each other. Each indicator variable was tested for convergence using a variety of tools. Considering appropriate chi squared values, and the statistical significance of factorial loadings, a high level of convergent validity was shown – with all Bentler-Bonnett coefficient values close to one ($0.975 \rightarrow 1.0$), and the individual factorial loadings of each driver having t values above 1.96.

Principal Component Analysis; Oblique Rotation with Kaiser Normalisation. (All estimated parameters are statistically significant at 95% ($t > 1.96$))

IV. 6 Discriminant Validity

Discriminate Validity was tested using Bagozzi & Phillips ‘pairwise test’ to determine whether paired factors fitted the data better than a single factor. A series of chi squared difference tests were conducted. Here, at p values of 0.000, each showed statistically significant differences. Thus from their correlation values, the drivers were interrelated, and each concept differed from the other. Hence, the existence of discriminant validity was affirmed.

V. Discussion

The analysis of marketing-services aspect of this tool has been discussed above. It is a reliable, viable, useful tool.

The WQA offers a simple, yet highly useful, means to compare relevant competitive (or benchmarked) websites. It

offers a mechanism to better understand differences between competitors. A comparative benchmarking standard may be established, allowing a business like an on-line real estate firm to enhance its relative competitive position using value-added features such as - distance to local schools, average time to drive to city, local council contacts, help services, and the like. It may then develop a more 'customerised' [24][25] services-product suite – offering increased 'one-on-one' customer satisfaction [26], and possibly, increased return on investment (and profit) [16].

Table 6: Oblique Pattern Matrix Factor Loadings: WQA Marketing-Services Sector

	Component				
	Presence	Searchability	Value Adding	Marketing	Creativity
Co. Representation	0.843				
Prod. Representation	0.834				
Product Info.	0.723				
Company Info.	0.523				
Location		0.917			
Accuracy		0.862			
Clicks		0.617			
Price		0.604			
Links			0.779		
Relevance			0.717		
Tools			0.666		
FAQ			0.514		
Portrayal				0.800	
Segmentation				0.730	
Price Range				0.611	
Promotion				0.531	
Video					0.827
Theme					0.757
Text					0.695
Photo					0.597

VI. On-Going Research

A valid tool for comparing and benchmarking websites is now under development, with a computerised version of the WQA currently being prepared for commercial release.

One limitation within the marketing-services sector of the WQA remains to be solved. Within a couple of features inside the total IT marketing-services sector, occasional difficulties were encountered by users when rating certain complex feature components. This technical weakness in measurement capture is currently under investigation for both the marketing services, and the IT sectors of the WQA. New additional measurable component datasets are under test, and are likely to be incorporated into the final computerised WQA model.

Another area possibly warranting additional investigation is the issue of 'search', or 'trawling the web to locate a website'. The ability to find a website is vital for both the

user and the vendor. Other 'search for airline' studies [20][21], further highlight such problems. Research into 'search' requires additional structured experimentation, and was considered beyond the initial scope of this research.

VII. Conclusions

The marketing-services sector of the WebQuality Analyser (WQA) is an empirically validated, useful tool for the analysis of e-business enabled web sites. When married with its IT sector, two previously disparate approaches to benchmarking websites deliver a new, empirically developed benchmarking and comparison tool. The WQA is more accurate than existing alternatives. It unites: (1) a process oriented analysis involving the stages within the trade cycle, with (2) a HCI approach (focusing on technology, R&D outsourcing, application development, client focus, and core business delivery) treating user or client visits as personalised website e-business-client encounters. Overall, the WQA contains the key elements necessary for valid, detailed, assessment of websites.

The use of the WQA as a benchmarking and comparison tool, also contrasts with the website 'gut reaction' often provided by web users. Schaffer and Sorflatten [91], report that many web users assess a web site as: too slow; disorganised or confusing; or not offering the required service; and then move-on - to other websites! The 'gut reaction' does not deliver an objective basis for benchmarking or comparing websites (other than on a two point scale), nor for planning website improvements. In comparison, the WQA delivers a thorough, empirically supported and well tested benchmarking tool. In addition the WQA delivers an instrument that may be used as a strategic management tool.

Thus, this research supports the use of the WebQuality Analyser's the five marketing-services sector drivers and their inherent features as indicators of marketing-services website quality.

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Author Profiles:

John Hamilton is the Director of E-Business at James Cook University. His extensive domestic business ownership and management experience includes: importing, exporting, mining, rural, wholesale, manufacturing, and several small-medium businesses (supermarket, video wholesale, fashion stores, florist/gifts, restaurants,) His international business experience includes: Sapphire mining, processing and gemstone sales; plastics manufacturing; importing/export-

ing; and international finance.

John Hamilton is a driver of innovation, market leadership, and creative thinking. He developed: the world's first abalone aquaculture farm - and perfected live export techniques (1980-4); rock lobster aquaculture procedures (1981-4); a plastics manufacturing plant in China (1987-8); computerised sapphire gem cutting machine technologies (1991), offshore financing procedures (1991), Ed .Qld.'s Centre of IT Excellence - programming, database implementation, e-commerce, multimedia, robotics and communications technologies (1994-2001); and JCU's MBA/MIT E-Business strategic initiative (2002-2005).

John Hamilton has extensive business, management, consulting and research experience. He is an active researcher. His current specialisations include: development of strategic web-based instruments; QFD; strategic positioning; strategic e-marketing; logistics, killer strategies for business; service value networks, industry-wide future technologies and solutions; and the performance, value and alignment of customer-business interfaces.

Roy Wybrow has worked in IT/IS business related fields including aircraft R&D, engineering, e-commerce and ERP for various MNE's in Vietnam, China, Malaysia, Fiji, Papua New Guinea, and Australia.

He lectures in statistics, e-business, communications technologies and venture management at James Cook University.

He is a skilled researcher, especially in the statistics and information technologies arena. He is currently researching across a wide range of industrial sectors to determine the factors driving successful industrial clusters.

His consulting firm has identified, developed, and commercialised, many unique business solutions including: computerised fruit picking, energy efficient housing, sophisticated IT/IS solutions for business, and value adding, peripheral, sugar-based industries and associated industrial clusters. He has also consulted, developed and implemented Balance Scorecards for SME's.

Managing Wireless Communications in Taxi Services

Ziqi Liao

Department of Finance and Decision Sciences

Hong Kong Baptist University

Kowloon, Hong Kong

Telephone: (852) 34115227 e-mail: victor@hkbu.edu.hk

Abstract: This paper describes the wireless communications in the context of taxi service operations. Human-system interaction is necessary to taxi vehicle dispatching. However, the process is influenced by various variables in relation to dispatch data conveyed to drivers, display panel, mechanical noise and vibration. The in-vehicle wireless dispatch interface must be ergonomically designed to cope with environmental influences. The findings have practical implications for managing services operations.

Keywords: Technology management, service operations, wireless communications

I. Introduction

The Automatic Vehicle Location and Dispatch System (AVLDS) has been implemented by several taxi companies such as Comfort, CityCab and Trans-Island Bus Services in Singapore. It effectively supports the operations management of taxi fleet and considerably enhances the taxi services. The AVLDS comprises differential Global Positioning System (GPS), wireless data communications, computerized dispatch systems and interactive voice responses. A number of stations have been established for the transmission of data between the control center and individual taxi vehicles equipped with GPS antenna, receiver and transmitter. The system can immediately detect the nearest taxis to a particular customer, and identify each vehicle's route and location. Therefore, it enables the taxi company to immediately respond to a customer request for taxi service. It also enables collaborative operations between call operators and individual taxi drivers. This paper presents the wireless dispatch process and discusses the environmental variables in relation to in-vehicle human-system interactions.

II. Dispatch Operations

The GPS has been extensively used for vehicle navigation and transportation management [1] [2] [3] [9]. In the present case, the GPS-based dispatch system can automatically locate taxi vehicles running within ten kilometers to a customer when a request for service is received from a dedicated terminal or an automated call handling system. It is a significant improvement over the radio-paging system

used previously. The computer-assisted dispatch process involves the transmission of a request for service via wireless data communications to a number of taxi vehicles. When a job is circulated, a taxi driver can easily respond to the control center by pressing a button on an in-vehicle dispatch device if he would accept the job. However, if the drivers of those taxis within ten kilometers do not respond to the request for service within a preset period of time, the system will automatically search for the next nearest taxi vehicles and the job will be dispatched again. Upon successful matching, the taxi number and expected time of arrival will be immediately relayed to the customer. As a matter of fact, the expected time of arrival is relatively accurate, because the system has the capability to continuously calculate the time needed for the taxi to arrive at a particular destination. Although the system tends to circulate a job to those taxis within a relatively short distance to a customer, it is able to relay different zones to track other taxi vehicles.

III. Interface

The wireless dispatch device installed in the taxi vehicle enables a driver to read message, send message and review job record. The driver can easily read the dispatch data on the display including name of a customer, pick-up address and time. He can also communicate with the control center using a few keys on the device. For instance, if he presses "Auto" on the device, he will be given a job when his vehicle is identified closest to a customer. In this case, he must accept the job and proceed to the pick-up point, when there is a service request appearing on the panel. On the other hand, if the driver presets "Can Bit" on the device, a request for service together with the pickup address and time of a customer will be received from time to time. If he would like to take up the job, he must bit for it by pressing a "Bit" bottom. Because a number of taxi vehicles may receive the same request for service concurrently, he should respond to the request quickly in order to get the job.

The in-vehicle wireless dispatch device can automatically record and memorize the job completed by a driver. Table 1 shows a record of the sixteen jobs done by a driver on a particular day. In this case, he has completed five jobs (i.e. requests for service) allocated by the control center. In addition, he has served nine different customers hailing taxi service on the street and a customer specially arranged (i.e. special job done). Moreover, there is an "advance register" because the driver has a regular service of sending

someone to office at 8:30 am every morning. Lastly, he has accepted an advance booking to the airport at 6:30 am next morning.

Several functions associated with the in-vehicle device are summarized in Table 2. If a driver is not sure of the venue and is not able to locate a customer to a particular designation, he can easily ask the control center by pressing "Address not clear." He can also communicate with the control center through wireless mobile phone. The system can provide a taxi driver with road information, route guidance and assistance, since the geographical information system associated with the AVLDS contains a database with electronic maps and road directory.

The driver can inform the control center "Late for pick up," in case he recognizes the difficulty to reach a particular customer on time due to heavy traffic. He can also tell the control center "Far from pick up," if he believes that there is a relatively long distance between his current location and the pick-up point of the customer. Moreover, the driver can report to the control center and request for towing service if his vehicle is breakdown or has any malfunctions. He can also report to the control center if there is a traffic accident. Accordingly, the control center can ask ambulance and traffic police for assistance. Finally, the driver can inform the control center in case of any emergency through a hidden alarm activator, while the control center can immediately identify the location of the taxi and provide prompt aid to the driver.

Table 1 An Example of Job Record

Job specification	Number of job
Call job done	5
Street job done	9
Special job done	1
Advance register	1
Total job done	16
Job rejected	0
Advance job accepted	1

Table 2 Report to Control Center

Function key	Request for assistance
1	Car breakdown
2	Address not clear
3	Far from pick-up
4	Late for pick-up
5	Car accident
6	Towing service
7	Radio me every five minutes

The AVLDS improves the communications between control center and taxi drivers, because it not only enables the transmission of dispatch information in a precise manner, but also cultivates a collaborative operational platform for call operators and taxi drivers. The previous radiophone often caused misunderstanding between a call operator and

taxi driver, because both sides had to withstand the drone of sound emitted by phone. Hence, the customer reservation information conveyed by the call operator to drivers might be distorted. In comparison with the previous radio paging system, the working environment of call operators has been greatly improved since the noise level has been considerably reduced.

The system eliminates ineffective communications, because the reservation is digitally transmitted to different in-vehicle devices. In particular, the standardization of data entry and data processing enables an operator to easily handle several calls within a specific time frame. As a result, it permits more reservations to be processed with the similar level of manpower. The efficiency of call operators has been enhanced, because the system effectively enables the call operators to match the call for taxi service from individual customer. With the implementation of the system, the operator is able to quickly retrieve the pick-up location when receiving a call for service.

Many public telephones are equipped with automatic-dial services in Singapore. For example, one can reserve a taxi by pressing the CabLink Hot Button, which is a label indicating one of the taxi companies at a public telephone. Such a request for service will directly go to the dispatch system of that company, in which the reservation is instantly processed because the pick-up location can be automatically identified. Finally, individual customers are encouraged to register the use of the GPS-based dispatch system. Hence, the taxi company can provide them with more customized services. For instance, a regular pick-up at a particular point of time can be arranged for a customer.

IV. Discussion

The implementation of the AVLDS effectively facilitates the management of large number of taxi vehicles and enables the achievement of operational efficiency. The taxi drivers have benefited from the system, because it helps reduce operating costs, obtain on-line route guidance and ensure security and safety. Prior to the use of GPS-based dispatch system, it was not uncommon that an average cruises empty was about 40% of the time. The drivers not only wasted his time, but also used additional fuels. Today, the taxi company is able to accept more reservations, thus creating more jobs for taxi drivers. The drivers have experienced an increase in productivity, because they can serve more customers, while decreasing daily operating costs and empty cruising. Some even prefer to wait until the system matches them with the nearest pick-up point of a customer.

The wireless communications and human-system interactions are influenced by a number of environmental variables [4] [5] [6] [7] [8]. It is therefore necessary to develop an ergonomic in-vehicle interface. The wireless in-vehicle device plays an important role in facilitating communications and dispatch operations. It also enables individual taxi drivers to effectively communicate with the control center and respond to a request for service. The

concerns in relation to the human-system interactions include the installation of in-vehicle dispatch device, data presentation on the display, manual operations of the device and the impact of external environment.

The wireless in-vehicle device should be installed close to the driver without interfering automotive instrumentations. When receiving a dispatch message appearing on the display panel, the driver may pay less attention to the road condition, and his attention might shift away from the primary task of driving. In particular, he has to read the message on the display in bright condition such as direct sunlight. Although the brightness of the display can be manually adjusted, the device must be properly installed to avoid extremely bright lighting. It should also enable the driver to read the dispatch data in the dark environment. The dispatch data conveyed to drivers should be short and precise.

The control functions of the wireless dispatch device have an impact on drivers' interactions with the system. Some drivers might not be able to adapt the system within a short period of time. Therefore, manual operations for responding to a request for service should be simple and easy to use, while unnecessary data transmitted to the panel should be eliminated. It might be difficult to customize an in-vehicle display to different drivers. The template of distributing dispatch data should be standardized. Some simple symbols should also help drivers appreciate a dispatch message and react to a request for service.

Finally, the noise mechanically generated by the vehicle considerably influences a driver's response to a request for service. A steady noise from the engine might compete with audio alarms and voice messages. In order to draw the driver's attention towards the dispatch data, the audio output of impulse noises emitted in short burst from the dispatch device should be adjusted appropriately. Finally, the driver has to pay more attention to the road condition when there is a significant vibration. The dispatch data conveyed in such a circumstance might affect the driver's performance and impair his ability to drive safely. The impact of vibration should be taken into account when installing the dispatch device. In sum, there are a number of variables in relation to dispatch data conveyed, display panel, mechanical noise and vibration. Because these variables considerably influence the communications and dispatch operations, they must be

ergonomically handled when designing the dispatch devices.

V. Conclusion

The effective wireless communications interface facilitates the improvement of taxi services in terms of time required for processing reservations and dispatching vehicles. With the AVLDS, customers are able to conveniently reserve taxi service at a particular pick-up point such as office and home. They can also easily get a taxi at different locations. In addition to vehicle tracking and dispatching, the system provides useful data for the management of taxi operations and helps the taxi company to optimize the use of limited resources. It also enables the taxi companies to achieve higher productivity and better service quality. However, the interface of wireless communications must be ergonomically designed in order to achieve the expected capacity of the dispatch systems. Environmental variables associated with in-vehicle operations must also be effectively tackled. The present observations not only provide information for improving taxi services, but also have practical implications for managing service vehicles in different environments.

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Assessing of a New Customer Services System's Use in Internet Environment

Chuan-hua Zhou¹, Bao-hua Zhao²

¹ School of Management Science and Engineering, AHUT, P.R.China, 243002

² University of Science and Technology of China, P.R.China, 230026

Tel./Fax: 86-555-2400854 E-mail: chzhou@ahut.edu.cn

Abstract: Assessing use is very important for organizations selling and using customer services system in Internet environments. Based on a conceptual model, this paper is to empirically study individuals' assessments of a new customer services system in Internet environment. The model has three phases; pre-use, test and use. In relation to the three phases, the concepts of value and quality are discussed. The main contribution of this paper is the understanding of the difference between the concepts of value and quality being illustrated in the conceptual model. Customers' assessment of value and quality could have implications for companies developing new customer services system in Internet environments.

Keywords: Assessment, Customer services system, Quality, Value.

I. Introduction

Assessing use is of vital importance for organizations selling and using services in Internet environment (Davis et al., 1989; Philip and Hazlett, 2001). In the areas of information technology and management the introduction by Davis (1989) of the technology acceptance model (TAM), was in many ways pioneering in understanding the psychological factors influencing information system use. Davis emphasizes the role of the individual in the organization. Furthermore, Orlikowski (2000) puts forward that since most technologies can be used in a number of ways, users shape the meaning of technologies as they integrate them into everyday practice. Emphasized in this paper is the users' interaction with technology solutions in everyday practice in an organizational context.

Bobbitt and Dabholkar (2001) share a similar understanding as Davis (1989) when they put emphasis on attitudinal beliefs to predict and understand use of technology-based self-services. Not entirely emphasized in the models by Davis (1989) and Bobbitt and Dabholkar (2001) is a broader understanding of usage than attitudes and intentions of usage, because intentions predict use, but not usage over time (Chau, 1996). Karahanna et al. (1999), on the other hand, put forward the importance of studying technology adoption across time. Karahanna et al. highlight the importance of organizational issues and the affect on the individual, particularly for potential adopters of information technology. A framework is presented where they

combine innovation diffusion and attitude theories to study differences in pre-adoption and post-adoption beliefs and attitudes. The consciousness of the difference between adoption and usage is a critical factor when understanding adoption. The importance of different phases in time, by Karahanna et al. (1999) labelled pre- and post-adoption, is of equal importance in this paper.

In addition to the distinction, made by Karahanna et al. (1999), in pre-adoption and post-adoption, a middle phase is implemented in the conceptual model presented in this paper. The middle phase is labeled the test phase. The reason why assessment of usage of a new customer services system in Internet environment should contain an additional phase is users involvement in development processes and its affect on users' assessment of the service in Internet environment in the test phase. Therefore, when users are involved in the development process of a new service in Internet environment, the assessment of usage should be based on three phases (Figure 1). The purpose of this paper is to use a conceptual model (Figure 1) to empirically study individuals' assessments of a new customer services system in Internet environment over time.

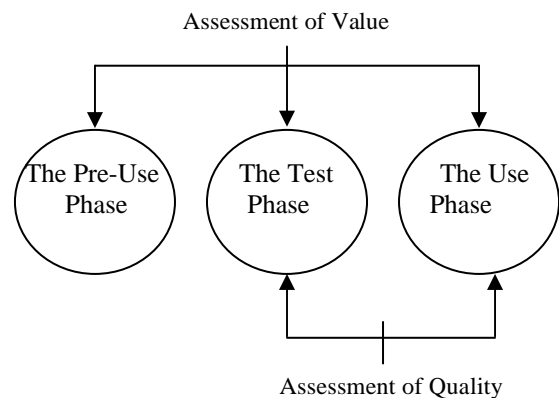


Fig. 1 User Assessment of Value and Quality of a New Service in Internet Environment.

In connection with these three phases, two concepts of great importance for user assessment will be discussed. The concepts are value and quality. McDougall and Levesque (2000) put forward that the concepts of quality and value are closely linked; "quality is just one side of the satisfaction equation." (p. 403). However, the difference between the concepts of value and quality is the main contribution of the conceptual model (Figure 1). The underlying principle of our model and the reason why the concepts of value and quality are important is that users' ability to assess the value of a service in Internet environment is possible without usage.

As for quality assessment, usage of the service in Internet environment is a requirement.

The structure of this paper is as follows; first, a brief introduction of the concepts of value and quality will be carried out. Thereafter, a discussion of the three phases will be presented with regards to the concepts of value and quality. In conjunction, early results from an ongoing study will be presented. Data collection in this study has been generated by the means of qualitative in-depth interviews over a period of two years. Interviews have been conducted with four pilot-customers of a new service in Internet environment in three different time phases, i.e. the pre-use, the test and the use phase.

II. Value

Perceived value is a difficult concept in that it is hard to define and measure (Zeithaml, 1988; McDougall and Levesque, 2000). Broadly defined, perceived value is the results or benefits customers receive in relation to the total costs. In other words, it is the difference between perceived benefits and costs (McDougall and Levesque, 2000).

According to Zeithaml (1988), customer-perceived value is the consumer's overall assessment of the utility of a product based on a perception of what is received and what is given. This can vary between people but also from occasion to occasion for the same person (Zeithaml, 1988). Caruana et al. (2000) state; "value is seen to be more individualistic and personal than quality and involves both a give and get component" (p. 1339). Raval and Grönroos (1996) suggest that customer-perceived value has to be related to different personal values, needs and preferences. In addition, they state, that the financial resources of the consumer must be taken into account.

III. Quality

Quality originates from Latin and means the attribute or the constitution of something. The ground of the competition is made up by the customers' experience of quality in relation to the costs (Edvardsson, 1996). Grönroos (2000) presents the concept of total perceived quality building upon the gap between expected and experienced quality.

Palvia et al. (2001) present a socio-technical framework for quality assessment of computer information systems. When assessing a system, the authors state; "the quality of an information system should be concerned with both the technical and the social subsystems. The technical subsystem covers the nature of the tasks to be accomplished and the technology that enables their accomplishment. The social subsystem involves the individuals who are responsible for accomplishing the tasks and the means whereby their work can be coordinated. In short, the assessment of system quality reflects the task, the supporting technology, the people involved and the organization" (p. 238).

For individuals and organizations, value and quality are two important aspects. As a consequence, questions about how value and quality are perceived by individuals are essential when services in Internet environment are developed and assessed. Below, the concepts of value and quality will be discussed in conjunction to the three phases of the conceptual model (Figure 1). Based on a chronological order, the first phase, the pre-use phase will be presented, followed by the test phase and finally the use phase. The presentation will focus on theoretical as well as empirical findings.

IV. Empirical results

For individuals and organizations, value and quality are two important aspects. As a consequence, questions about how value and quality are perceived by individuals are essential when services in Internet environment are developed and assessed. Below, the concepts of value and quality will be discussed in conjunction to the three phases of the conceptual model (Figure 1). Based on a chronological order, the first phase, the pre-use phase will be presented, followed by the test phase and finally the use phase. The presentation will focus on theoretical as well as empirical findings.

IV. 1 The Pre-use Phase

The first phase in the conceptual model is the pre-use phase. At this point the potential user has a service present-at-hand, which means that information about the service and/or visual experience are the only sources available for the potential user to assess the service in Internet environment (Winograd and Flores, 1996). The importance of the pre-use phase is highlighted by Barki and Hartwick (1994), where they argue that it may be more easy to change users' "thoughts and feelings" before implementation. Early results from the study show an overall positive attitude towards the future service in Internet environment. Possible explanations could be that users perceive the service in Internet environment to be valuable or that users involvement in the development process has influenced users thoughts and feelings in a positive manner.

Davis et al. (1989) state that the most vital problem, when assessing user acceptance of IS in the early stages of development, is the difficulty to give users a clear picture of features and functions of the new system. Likewise, our study shows that although pilot-customers were given a short introduction in the early stages of the development of the upcoming service in Internet environment, they had difficulties in expressing opinions about the quality of the service.

Davis et al. (1989) discuss the importance of finding new methods for evaluation of acceptability of a system as early as possible in the development of information systems. This could better help to decide if the system needs to be changed and decrease the risks of developing a system that is not going to be used. The overall picture in our study is that

pilot-customers feel that they have had good opportunities to share opinions and concerns regarding the upcoming service in Internet environment. Pilot-customers concerns of missing features and functions in early presentations of the upcoming service in Internet environment were taken into consideration and later developed and implemented into the service. In line with the conceptual model (Figure 1), pilot-customers in the pre-use phase were able to express general opinions about quality issues, but not to make assessment of quality issues. However, assessment concerning values of features and functions of the upcoming service in Internet environment were possible to express opinions about.

IV. 2 The Test Phase

Emphasized by Davis et al. (1989) is the interest in the possibility to forecast and explain user behavior after a very short time of interaction with a system. In order for computer systems to improve organizational performance they must be used (Davis et al., 1989). As the users interact with the service in Internet environment in the test phase, it is possible to form a judgment about the quality, or excellence of the service (Zeithaml, 1988). After the pilot-customers had used the in Internet environment service for approximately a month, value and quality assessment were easier to express opinions about.

Orlikowski (2000) points out that technology users shape the meaning of technology as they integrate them into everyday practice. In other words, technology structures are not external from the user. In the test phase, the user repeatedly interacts with the service in Internet environment, which shapes their view about it and accordingly their use. Davis (1989) suggests that two determinants, "perceived usefulness" and "perceived ease of use", are especially important when people accept or reject information technology. Both variables influence users' attitude, intention and finally behaviour. In the test phase, as in the pre-use phase, the role of the individual is critical. It is of utter importance for the success of the application that the user finds it useful and easy to use. In our study, pilot-customers expressed difficulties in using the service in Internet environment for the first time. It was not obvious how to make an error-report in the service in Internet environment, although error-report is an essential function of the service. Pilot-customers assessments are important to take into consideration in the test phase since the determinant "perceived ease of use" (Davis, 1989) will have an influence on users behaviour in the use phase.

IV. 3 The use phase

In the test phase, but even more apparent in the use phase, the user gradually becomes more aware of the service in Internet environment not only in the own working tasks but also in the organizational context. As Palvia et al. (2001) point out, when assessing a computer information system, a wider socio-technical view is important. Therefore, the

quality of a computer information system should be concerned with both the technical and the social subsystems. A longer use of a service in Internet environment in an organizational context, "technology-in-practice" (Orlikowski, 2000), will have implications for users' judgment when assessing the service in Internet environment in the use phase.

Hu et al. (1999) state that the organizational context is new to IT acceptance and adoption research. Taylor and Todd (1995) argue for the importance in understanding determinants of information technology usage in organizations. Barki and Hartwick (1994:77) state that when new systems have been implemented and used, feelings and thoughts among the users were "likely to have greater impact on the use of new systems". In accordance with Taylor and Todd (1995), the importance of organizational issues and its affect on users' assessing services in Internet environment will be stressed throughout the use phase.

V. Conclusion

Our findings in the pre-use and the test phase indicate support for the conceptual foundation of the model (Figure 1) that is, the difference between the concepts of value and quality in relation to user assessment in three time phases.

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Employee's Acceptance of Process Innovations: An Action Research Approach

Michael Amberg, Steffen Möller, Ulrich Remus
Business Information Technology
University Erlangen-Nuremberg
Lange Gasse 20, 90403 Nuremberg, Germany
Phone: +49-911-5302-801, Fax: +49-911-5302-860

Amberg@wiso.uni-erlangen.de,
Steffen.Moeller@wiso.uni-erlangen.de,
Ulrich.Remus@wiso.uni-erlangen.de

Abstract: Organizational changes are becoming more and more important due to increasing competition and rapid technological evolution. However, the intended benefits of organizational changes depend strongly on how effectively process innovations are implemented within an organization. Hereby, the management of the employee's acceptance is considered as one of the most critical tasks in change management projects.

Normally, employee acceptance is evaluated using theory-based acceptance models. We start by reviewing the existing process innovation-related acceptance models. In a next step, we describe a new model, called DART, which is based on the idea of the balanced scorecard, using a meta-structure in order to identify a balanced set of individually measurable acceptance criteria. Guided by an action research approach, we further describe a case example showing the application of DART in a process reengineering project.

We close our paper by reviewing the consequences of our research, as well as the suitability of DART in the research context. The results presented in this paper are expected to have important implications for both, researchers who should benefit from a very flexible acceptance model as well as managers and process designers who should gain valuable insights for their change implementation efforts.

Keywords: Process Reengineering and Redesign, Employee Acceptance, Process Innovation, DART, Action Research.

I. Introduction

Organizational changes are becoming more and more important due to increasing competition and rapid technological evolution. In order to successfully implement these changes, concepts of business process redesign have been introduced to improve performance and raise customer satisfaction.

However, the benefits of process redesign projects strongly depend on how effectively these process innovations are

implemented within an organization. Researchers as well as practitioners agree on employee's acceptance being a key success factor in change implementation projects ([23], [13], [18]). Neglecting employee's acceptance can cause resistance among employees, often leading to project failures.

Thus, the management of employee's acceptance is a crucial task in change management projects. According to DeMarcos "you can neither predict nor control what you cannot measure" ([15]), the detailed measurement of employee's acceptance is considered as a fundamental part in achieving this goal. Based on the acceptance evaluation, context-specific measures and actions can be taken, improving the overall acceptance of process innovations.

Usually, acceptance is evaluated with the help of theory-based acceptance models. Much research has been done at the organizational level, exploring the diffusion and the adoption of process innovations within an organization (i. e. [14], [16], [34], [33]). In contrast, on the individual level, only little research is done exploring individual reasons why employees accept or reject process innovations ([19], [22]).

Consequently, our research questions to guide this paper are: "What factors influence an employee's acceptance of a redesigned business process?" and "How can these factors be used to generate appropriate measures and actions to improve employee's acceptance?"

In order to answer these questions, we start by reviewing the existing acceptance models, which are focusing on the individual level. We then describe a new model, called DART which is based on the idea of the balanced scorecard using a meta-structure in order to identify a balanced set of individually measurable acceptance criteria. After the specification of the model, we describe a case example showing the application of DART in a process reengineering project guided by an action research approach. We close this paper with reviewing the consequences of our research as well as the suitability of the DART approach with regard to the research context.

II. Review of Existing Acceptance Models on the Individual Level

Process innovations are defined as "any innovation that changes the way a job is performed" ([20]). In general,

acceptance is defined as an antagonism to the term refusal and means the positive decision to use a (process) innovation ([5]). Acceptance research has its origin in both, industrial and business science. While industrial science focuses on the conditions of user friendly technologies and techniques, the business science discusses acceptance in various disciplines, e. g. marketing, organization, production theory and information systems research ([2]).

Here, employee's acceptance is discussed mainly from the perspective of organization theory and information systems research. Two classes of models can be distinguished ([20]): intentional models focusing on social and psychological issues and technology-related models focusing on process supporting technologies.

Intentional models highlight the intention of individual employees, in most cases unspecific to process innovation characteristics. Consequently, psychological models like the Theory of Reasoned Action (TRA, [17]), the Theory of Planned Behavior (TBP, 0), and the Goal-Setting Theory (GST, [21]) are applied.

The second class considers organizational changes by combining process and technological innovations. They usually rely on marginal extensions of technology acceptance models like the Technology Acceptance Model (TAM, TAM2 [12], [37]) or the Task-Technology Fit model (TTF, [19]). Table 1 provides an overview of common models together with their core constructs and a brief summary.

Table 1: Overview of common models utilized for the acceptance analysis of process innovations

Acceptance model	Core constructs	Short summary
TRA	Attitude toward behavior and subjective norm	TRA is one of the most fundamental and widely-used theories of human behaviors drawn from social psychology.
TBP	Attitude toward behavior, subjective norm, and perceived behavioral control	TBP extends TRA by adding the construct of perceived behavioral control.
GST	Situational and personal factors influencing the valence and the expectancy of goal attainment	Individuals use their personal and situational beliefs and attitudes to formulate goal commitments before taking action.
TAM (TAM2)	Perceived usefulness, perceived ease of use, (subjective norm)	TAM/TAM2 is designed to predict information technology acceptance and usage on the job.
TTF	Technology, task, individual	Task-oriented approach to address the acceptance of IT systems in a specific job context.

Previous studies, which compared the explanatory power of the difference classes of models revealed, that none of the classes is superior (cf. [30]). As consequence, integrated models, using elements from both, intentional as well as

technological-related models are developed and discussed in literature (cf. [36], [38]).

Although both classes of acceptance models are based on mature research areas providing valuable insights, the unspecific foundation of the models leads to an important problem: Specific acceptance criteria related to process innovations are widely ignored due to the limited perspective of the adapted models.

To address this shortcoming, a generic but adaptable framework considering process innovations is needed. A framework, which helps to identify individually important, measurable and independent acceptance criteria, is presented in the following section.

III. Specification of the DART Acceptance Model

DART is a highly flexible acceptance model, designed for the analysis and evaluation of user and employee acceptance in a variety of different application areas, e. g. situation-dependent mobile services, web based aptitude tests and enterprise portals (cf. [2], [3], [4], [5]).

According to Amberg et al., the fundamental design criteria of DART are:

- The use as a permanent controlling instrument,
- A balanced consideration of relevant influencing factors,
- The applicability during the whole development and implementation process, and finally
- The adaptability to individual requirements of the research item ([2]).

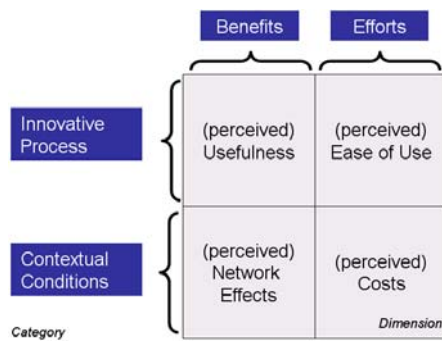
These design criteria are useful to integrate acceptance analysis into the development, evaluation, and implementation of process innovations. In the following, we describe the architecture of DART.

III. 1 Architecture of DART

DART is based on the idea of the balanced scorecard using a meta-structure in order to identify a balanced set of individually measurable acceptance criteria ([25]). As a key characteristic, DART's meta-structure emphasizes the employee's individual point of view by an explicit consideration of the employee's perception ([39]).

DART uses the following complementary and orthogonal categories:

- Benefits and Efforts comprising all positive and negative facets of process innovations (cf. TAM, TTF).
- Process Innovation and Contextual Conditions including basic socio-cultural and economic conditions, which also have an important impact on employee's acceptance (cf. TRA, TBP, and GST).

Fig. 1: Meta-structure of the DART acceptance model

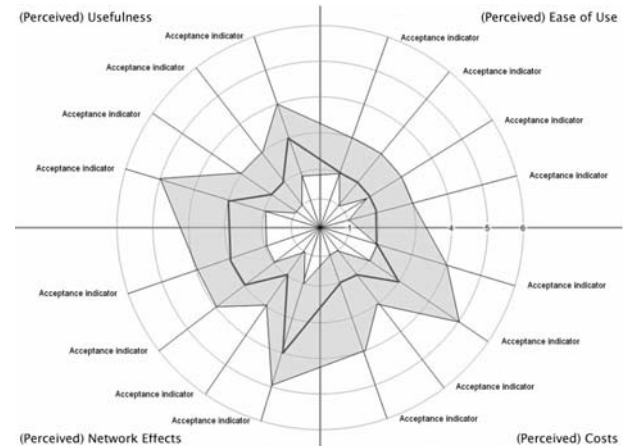
These categories lead to four acceptance dimensions that are relevant for an in-depth analysis of the employee's acceptance (Fig. 1):

- (Perceived) Usefulness, build by the categories benefits and process innovation, describes the individually perceived usefulness of a process innovation (cf. [12], [37]). Acceptance criteria of this dimension might be employee motivation or change demand.
- (Perceived) Ease of Use, characterized by the categories of process innovation and efforts explain the degree to which a person believes that using a particular process innovation would be free of effort (cf. [37]). Criteria measuring this dimension are for example the adaptation effort or the process complexity.
- (Perceived) Network Effects: The categories benefits and contextual conditions lead to the dimension of perceived network effects. The dimension considers the contextual aspects of a process innovation depending on economical, social and organizational factors (cf. [17]). Stakeholder Support and External Motivation are typical criteria to measure this dimension.
- (Perceived) Costs finally formed by the dimension contextual conditions and efforts describe the monetary and non-monetary efforts not directly associated with the process innovation itself (cf. [19], [21], [11]). Suitable acceptance criteria might be Individual Uncertainty or Risks.

The resulting structure supports a systematical identification of acceptance criteria. According to the BSC approach, the intention is to find a set of precise criteria with high significance, meeting the requirements of sustainability, measurability, achievability, reasonability and timeliness. No complete set of acceptance criteria is defined in advance; rather they have to be defined according to the concrete research item.

In addition to the meta-structure, DART provides a visualization approach for an appropriate visualization of the employee's acceptance. DART's visualization approach is based on spider charts, being composed of several radial spokes, one representing each acceptance criteria. The acceptance criteria themselves are structured by the means of the DART meta-structure, which means, they are classified in

the DART categories and dimensions (cf. Fig 2).

Fig. 2: Visualization approach of DART (DART chart)

The results of the acceptance evaluation should be quantified and normalized, e. g. by using a scale from one to six as shown on the horizontal axis in the figure above. The minimal value is located near the center of the chart (e. g. the value of one) illustrating a high acceptance level, while the maximum value near the border of the chart (e. g. the value of six) indicates a low acceptance level.

Using this scale together with the meta-structure of DART, an individual acceptance curve can be drawn (bold black line in the figure). This acceptance curve represents the average acceptance level for each acceptance criteria (the statistical median). The statistical spread resulting from the spread of opinions in the survey could be used to draw a surface (utilizing the upper and the lower quartile, cf. [39]). According to the visualization, acceptance criteria receiving a median located in the upper range of the scale (e. g. in the range four up to six), are considered as acceptance challenges. With regard to the statistical spread, acceptance challenges are considered as critical if the lower quartile (the outward bound of the gray area) reaches the highest possible acceptance level (e. g. the value of six). This indicates that a significant number of employees strongly disagree with the process innovation.

The used presentation is similar to the popular dart game where a dart hitting the centre of the disc denotes the highest possible score. By means of this visualization approach, potential acceptance challenges and resistances can easily be identified, addressed and eventually be reduced. In the next section, we describe a case example that shows the application of DART within a process reengineering project.

IV. Case Example: Application of the Acceptance Model

According to the research questions identified in the first section, the case example has two main goals: First, to analyze the general applicability and explanatory power of DART by generating suitable acceptance criteria, and second

to analyze DART's ability to generate appropriate measures and actions together with a review of the impact of those interventions.

IV. 1 Research Method

Because of the character of the acceptance evaluation, i.e. to provide insights and modifications to the research item, a research design supporting these interventions was necessary. According to Iverson et al., action research was chosen to be suitable ([23]).

Action research is defined as a widely-used class of iterative research methods aiming at solving practical problems ([35]). The use of action research is expected to produce "highly relevant research results, because it is grounded in practical action, aimed at solving an immediate problem situation while carefully informing theory" ([6]).

The central idea of action research is that complex processes can be studied best by introducing changes into the real world and observing the impact of those changes ([7]). Thus, intervention is the main instrument for knowledge generation in action research. Mingers consequently categorizes action research as an interventional, post-positivist research approach ([31]).

Action research was originally developed for the use in social sciences by Lewin ([26], [28]) and therefore has a long tradition in studying individual behavior. In the past, action research has led to a huge variety of specialized action research methods, detailed by Baskerville & Wood-Harper in [8].

In this research, we apply Checkland's action research cycle as one of the most widely used approaches ([9]). Checkland uses the following elements in his specification: an intellectual framework of linked ideas or a theory, a methodology of using this framework, and finally an area of application with specific research questions.

Checkland's action research cycle is composed by the following activities: Initiating, Iterating, and Closing. First, the concrete problem situation is entered by the researcher (Initiating). This includes the appreciation of the problem situation as well as a literature study of the concepts and existing models.

The second step (Iterating) comprises several activities, starting with the establishment of the roles of the researcher and practitioner in the corresponding area of research. Moreover, the research framework and the research methodology are based on literature study and practical experiences. Based on this framework, changes to the area of application are planned and scheduled. After that, researchers and practitioners take part in the change process. The second step closes with rethinking about the implemented changes and their effects. This in turn can produce two results: On the one hand, the effects of the implemented change may produce the expected outcome, thus, the cycle can be considered as successful and the loop can be exited. On the other hand, the reflection may show that an additional iteration is needed to rethink the framework and/or the implemented change. In this

case, the iterating phase starts again with the establishment of the roles.

In a last step, all experiences of the research are carefully reflected (Closing). This includes the refined framework, the changes on the problem situation itself as well as their impact, and eventually the suitability of the methodology itself.

In our case, the intellectual framework to be researched would be the DART approach. The methodology for using this framework would be the action research cycle by Checkland.

The selected area of application is a German company offering products and process-orientated services to the healthcare industry worldwide. At present, the company is dealing with the improvement and standardization of its IT processes aiming at a more effective, efficient and service-oriented structure. In order to achieve this goal the management chose to implement the IT Infrastructure Library (ITIL) standard in the IT Infrastructure division.

Our research was scheduled for eight months and included two complete action research cycles. The key activities of this study took place from December 2004 to July 2005. In the following section we start by describing the problem situation of our research in detail.

IV. 2 Initiating

The project presented in this paper focuses on the ITIL-based redesign and implementation of the technical change management process, which rules software and hardware changes to the production system. The project was chosen to be an interesting research item because of the following reasons: The project is of high strategic relevance, it affects a high number of employees (81) and the project could be accompanied through all important stages. At the beginning of our research, the process design team had already completed the as-is analysis and currently works on the redesign of relevant processes.

The impact of the changes varied across the seven teams of the IT infrastructure division. While the teams IT-Network and IT-Systems Management were considered to be affected in a major way, the other five teams were influenced in a less direct way.

Prior to the acceptance analysis itself, four brainstorming sessions were held to identify the key acceptance criteria. These workshops were attended by researchers and practitioners.

In further meetings, a total of 20 key acceptance criteria were identified and taken as basis for the subsequent analysis:

- (Perceived) Usefulness: Anticipated average life, change demand, employee motivation, transparent competences, and potential usefulness
- (Perceived) Ease of Use: Efficiency & effectiveness, integrity, employee integration, adaptation effort, and process complexity

- (Perceived) Network Effects: Communication, change agent qualification, organizational flexibility, stakeholder support, and external incentives
- (Perceived) Costs: Individual uncertainty, implementation costs, ongoing costs, opportunity costs, and risks

IV. 3 First Iteration

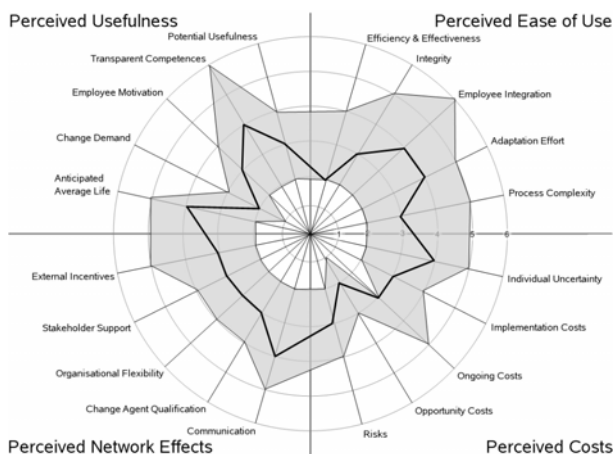
The first iteration was performed in the late design phase based on a draft of the new process. This draft provides an appropriate foundation for the acceptance evaluation because modifications on the process draft could easily be integrated.

The acceptance criteria identified in the previous section were used to develop a standardized questionnaire used for the acceptance survey. Each criterion led to a number of suitable questions. Based on experiences in other acceptance analysis, a six-point Likert scale was selected (cf. [29], [5]), ranging from strongly agree (indicated by number one) up to strongly disagree (indicated by number six).

Subsequent to the preparation of the questionnaire, a conceptional presentation of the process draft was prepared.

We performed three different evaluations. Next to the acceptance of the whole division, the two mainly affected teams IT Network and IT Systems Management were visualized separately (Fig. 3 to 5).

Fig. 3: Acceptance in the IT Infrastructure division (Total)



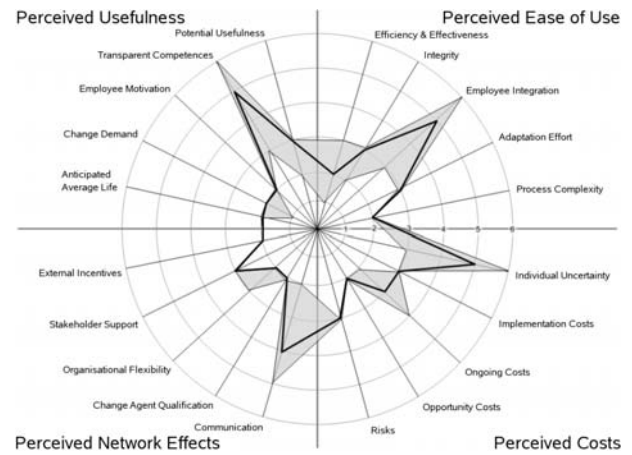
First, the evaluation of the IT Infrastructure division in general shows acceptance challenges especially located in the criteria anticipated average life, transparent competencies, employee integration, adaptation effort, individual uncertainty, and communication (each obtaining an average acceptance level of four).

The spread among the employees (the gray area) indicates a high diversity of opinions among employees. Furthermore, the acceptance levels of transparent competencies and employee integration are seen as critical, indicating that a high number of employees strongly disagree with these aspects.

The visualization of the IT Network Team (Fig. 4) shows that acceptance challenges are located within the same

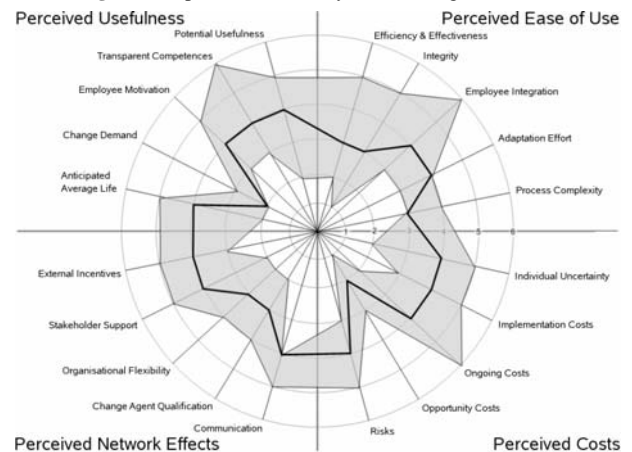
criteria as the whole division. The criteria transparent competencies, employee integration, and individual uncertainty (each obtaining acceptance levels of five) as well as the criterion communication (obtaining a level of four) are considered as acceptance challenges.

Fig. 4: Acceptance in the IT Network team



Comparing to the spread among the employees to the IT Infrastructure division as a whole, employees from the IT Network team largely agree on most acceptance criteria, resulting in a smaller gray area shown in the figure. As identified in the IT division as a whole, the criteria transparent competencies and employee integration are considered as critical, but this evaluation shows an additional critical criterion, the individual uncertainty.

Fig. 5: Acceptance in the IT Systems Management team



The DART chart of the IT Service Management team shows the most negative evaluation (Fig. 5). Acceptance challenges can be identified in 13 criteria, each receiving an average level of four: Anticipated average life, employee motivation, transparent competencies, potential usefulness, employee integration, adaptation effort, individual uncertainty, implementation costs, ongoing costs, risks, communication, stakeholder support, and external incentives.

Again, the statistical spread is considered as high. This time, the criteria transparent competencies, employee

integration, and ongoing costs are considered as critical.

To sum up, acceptance challenges can be located in several acceptance criteria, varying from team to team. In order to produce a positive effect for the whole division, and, at the same time, considering the importance of the mainly affected teams, we concentrated our further actions on acceptance criteria which appear in all of the three evaluations.

This led to the following four acceptance criteria: Transparent competencies, employee integration, individual uncertainty, and communication.

For each acceptance problem dedicated measures and actions were derived to improve the individual acceptance level:

- **Communication:** At first, communication was addressed by setting up a project-related intranet site which provides relevant documents, presentations and even the result of the acceptance analysis itself.
- **Transparent competencies:** To improve this acceptance criterion, it was necessary to clarify the redesigned process and to enlarge the supplied documents. Role based essays containing requirements, competencies, and responsibilities were generated to specify the future competencies in the teams more precisely and provided on the project's intranet site.
- **Employee integration:** Furthermore, regular discussion meetings about process-related issues were scheduled to increase employee integration. Moreover, a moderated discussion forum was established on the project's intranet site to enable employee's feedback in an independent and anonymous way.
- **Individual uncertainty:** To improve this criterion, the project goals, namely to improve and standardize IT processes, have to be communicated and clarified. Additionally, the management commitment to keep all jobs in the IT Infrastructure division was emphasized. It was expected that this could reduce the fear of job losses or the ambiguities about future requirements.

IV. 4 Second Iteration

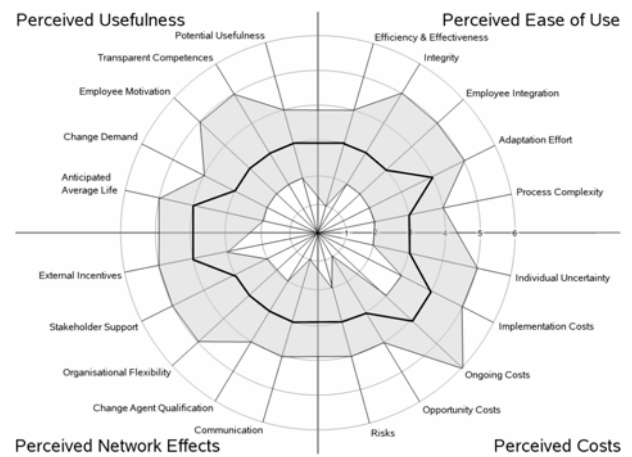
The second iteration was performed three months later, just before the implementation of the redesigned process itself. The analysis performed in this cycle was similar to the analysis of the first cycle, however with some minor modifications to the process with regard to the increase of transparency of competencies and affected roles, respectively.

The new process draft was presented to the employees in several workshops concluding with a discussion of the pros and cons of the new process. Subsequent to the discussion, all employees were asked to fill out the questionnaire again. Figure 6 shows the visualization of the evaluation results in the whole IT Infrastructure division.

The analysis could identify acceptance challenges especially in the criteria anticipated average life, adaptation

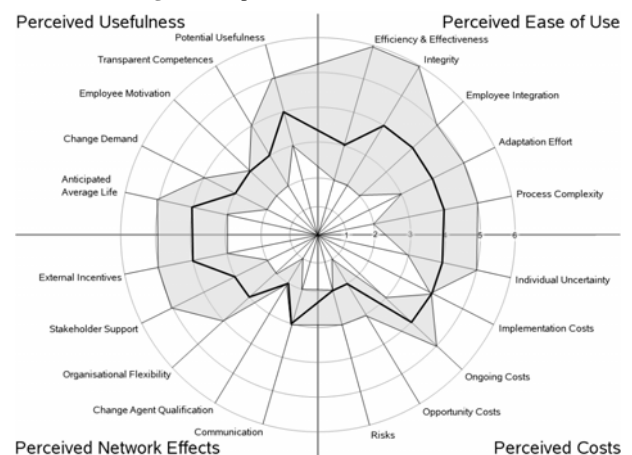
effort, implementation costs, ongoing costs and external incentives (each obtaining an average acceptance level of four). As already observed in the first iteration, the spread among employees is relatively high. However, only one acceptance criterion is seen as critical in this iteration (the criterion ongoing costs).

Fig. 6: Acceptance in the IT Infrastructure division (Total)



Comparing the results with the first iteration, the analysis shows that all addressed acceptance challenges could be improved significantly. Now, each of the four criteria shows an improvement of one acceptance level. Furthermore, all critical criteria could also be improved significantly. On the other hand, the analysis reveals a number of new acceptance challenges, located in four criteria whose acceptance level decreased in comparison to the first analysis, each by the value of one. The fifth acceptance challenge, the criterion anticipated average life, kept its level of the first iteration.

Fig. 7: Acceptance in the IT Network team

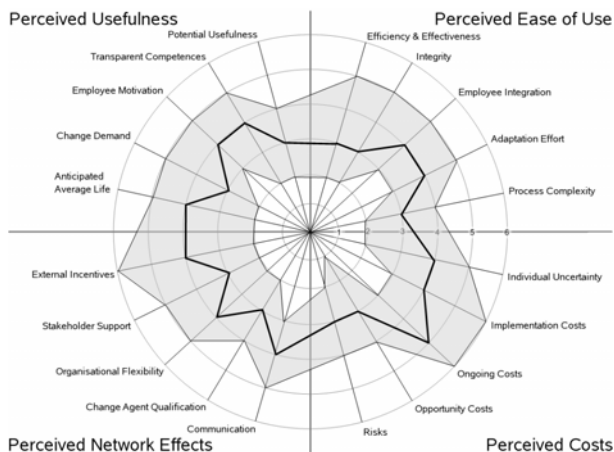


The analysis of the IT Network team (Fig. 7) also shows both, acceptance improvement as well as acceptance challenges. The following criteria are considered as challenges: Anticipated average life, positive usefulness, integrity, employee integration, adaptation effort, process complexity, individual uncertainty, implementation costs, ongoing costs, and external incentives. With regard to the

spread among employee's opinions, only the criterion integrity must be considered as critical.

Comparing the results with the first iteration, again, all addressed criteria could be improved by an average level of one up to two. Only one could be improved to level three and is therefore no longer considered as acceptance challenge (transparent competencies). All other criteria remain on acceptance level four and need to be addressed further on. Similar to the evaluation of the whole division, several new acceptance challenges emerge (in total seven), each decreased by an average acceptance level of one up to two.

Fig. 8: Acceptance in the IT Systems Management team



The analysis of the acceptance in the IT Systems Management team (Fig. 8) led to acceptance challenges in ten acceptance criteria: employee motivation, transparent competencies, employee integration, adaptation effort, individual uncertainty, implementation costs, ongoing costs, communication, organizational flexibility, and external incentives. The spread among employees was almost on a constant level. Critical criteria are implementation costs, ongoing costs and external incentives.

The comparison with the results of the first evaluation shows, that none of the four addressed criteria could be improved significantly. Nevertheless, the spread of opinions could be improved in two of the four criteria, namely transparent competencies and employee integration. Two additional acceptance criteria were identified as acceptance challenges.

Again, measures and actions were derived from the evaluation results. Here, four of the five acceptance challenges appearing in all of the three evaluations have been taken into account: Anticipated average life, adaptation effort, implementation costs, and ongoing costs. The external incentives challenge was left unattained, because of a lack of budget for dedicated incentives as well as unhelpful experiences of the management with external incentive systems in other change implementation projects.

- **Anticipated Average Life:** The acceptance challenge, which corresponds to the anticipated average life of the new process, indicates frequent business process changes

in the past. In order to support a stronger commitment towards the new process design, top management support is demanded.

- **Adaptation Effort:** In order to improve the acceptance challenge adaptation effort, the process design team decided to provide tools for reducing the individual change effort, e. g. document and e-mail templates. Selected employees were integrated into the development of these tools to ensure applicability and to reduce the individual change effort.
- **Implementation Costs:** This acceptance challenge seemed to be difficult to reduce because the corresponding budget was already spent on consulting by external ITIL experts and other process consultants. However, the discussion meetings revealed that the negative assessment of this criterion is correlated directly with the perceived lack of employee integration. For future change projects this will be kept in mind and more employees will be integrated into the change team and less consulting will be called externally.
- **Ongoing Costs:** Finally, the challenge at the criterion ongoing costs will lead to major changes in the process draft. The discussions revealed that the employees found their processes to be cumbersome and bureaucratic. As consequence, the whole process has to be simulated by the process designers and selected employees of all teams. In addition, process automation and workflow aspects will be discussed. It is expected, that this method will lead to more light-weight processes which reduces the negative ongoing costs perception.

At this point, it was decided to exit the iterations because of the time constraint of our project. Furthermore, our experiences from the two iterations already suggested that the DART approach was in a stable and useful form.

IV. 5 Closing

Finally, the two iterations were discussed and assessed at a closing meeting including senior management. The importance of the results concerning our research was emphasized by all participants leading the management to carry out additional acceptance evaluations in future change projects. As a result, the company's change management guidelines were extended by the necessary steps for the DART acceptance analysis. Templates for the questionnaire and the evaluation were generated and integrated.

Our final activity was to generate lessons learned, in particular with regard to our action research approach.

V. Discussion

Many authors provide universal tools for developing change commitment and acceptance (cf. [10]). However, in our research, we followed Dent and Goldberg expecting that only specific and targeted actions can contribute to the efficient

implementation of changes ([16]).

In this context, a multidimensional view on employee's intentions with respect to the proposed change was expected to enhance the accuracy in predicting employee behavior and acceptance ([32]). Therefore, we utilized the highly flexible and adaptable DART approach to identify a number of 20 acceptance criteria providing a differentiated, multi-facet view on employee's acceptance.

Further on, we didn't follow another common perception in literature, as Lawrence put it, the expectation that all the people involved in organizational change projects will resist the change in the same manner ([26]). Rather, employees, who are affected significantly by a change, provide a lower likelihood of commitment and acceptance ([11]). In order to analyze these possible different perceptions of change, we performed three evaluations of the employee's acceptance, one for the IT division in general and one for each mainly affected team, IT Network and IT Systems Management.

In a subsequent selection process, we defined acceptance criteria with a median of four or more as acceptance challenges. This selection is consistent with the corresponding literature, e. g. referring to Judson arguing that acceptance and resistance represent two poles of a continuum ([24]).

The selection of acceptance challenges in these three clusters led to a total of 13 (first iteration) respectively 14 (second iteration) distinct acceptance challenges. In order to reduce this amount of challenges to a manageable number, also with respect to the derivation of measures and actions, we focused on acceptance challenges that occur in all of our three evaluation groups. This led to 4 respectively 5 acceptance challenges (first/second iteration) which were addressed by further measures and actions.

If we look at the success of the measures and actions that have been carried out, we can see significant improvements of the corresponding acceptance criteria for the IT division in general and the IT Network team. The last team, IT Systems Management, doesn't show a significant reaction to our inventions.

Having Patterson and Conner in mind who claim, that building commitment to organizational change is a complex development process ([11]), our research clearly outlines both, the evolution of employee's acceptance as well as the maturing of our process draft over time. The importance of this development process is emphasized by Piderit in underlining the necessity of discussion and improvisation for revising the initial change proposal in an adaptive manner ([32]).

VI. Summary and Outlook

The purpose of our research was to develop a model that explains the employee's acceptance of process innovations in order to derive measures and actions to improve the acceptance.

After reviewing existing process innovation-related

acceptance models, we proposed a new model, called DART, which is based on the idea of the balanced scorecard, using a meta-structure in order to identify a balanced set of individually measurable acceptance criteria. Beyond the specification of the model, our paper also described the evaluation of the DART approach in a process redesign project.

In summary, our research findings confirm usefulness of the present model for generating suitable acceptance criteria as well as for defining corresponding measures and actions. Therefore, researchers are expected to benefit from an increased understanding of the employee acceptance as key influencing factor in change implementation projects. Managers and process designers should also gain valuable insights in their efforts to promote the acceptance of process innovations among employees.

Although we provide a balanced set of acceptance criteria, suitable for our individual research setup, researchers and practitioners must be aware of other factors that affect the employee's acceptance of process innovations.

The model proposed in this study represents a first step in developing a model of process innovations acceptance of individual employees. Further research will be required to test and extend the boundaries of the current model. For instance, the validity and reliability of our results need to be analyzed in one or more longitudinal field studies.

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A Project-Based Model for Implementing BPR

Hong Ling, Wei Yuan, Zhengchuan Xu
Department of Management Information System,
Fudan University, Shanghai, China
(86) 021-65644783; E-mail: hling@fudan.edu.cn
(86) 021-5507 2286; E-mail: 032025078@fudan.edu.cn
(86) 021-5507 4914; E-mail: zcxu@fudan.edu.cn

Abstract: Business process reengineering (BPR) is an outstanding management theory but with a high failure rates of 70%. One of the major problems in many BPR efforts is lacking of a disciplined method to model business process. In addition, the implementation methodologies in past literature and famous consulting firms were incomplete, and lack of practical experience or academic foundation. After analyzing and comparing the pros and cons of several representative BPR implementation methodologies, this study proposes a new methodology which combines previous academic outcomes and practical experience in consulting firms. Based on a hands on project, the detailed approaches, targets, needful materials, and expected results of each stage are elaborated as well as the commonly used BPR techniques and tools. Furthermore, the innovative methods and steps in this methodology which ensure the success of the project are discussed.

Keywords: Process reengineering & redesign, BPR implementation, methodology

I. Introduction

Business Process Reengineering (BPR) was a new management tool introduced by Michael Hammer and James Champ in early 1990s, and was defined as “radical thinking and redesign of business process in order to gain breakthrough improvement in the business performance, such as cost, quality, speed, and service”. Hence it quickly caught the imagination of western corporate leaders and became a major subject of attention in academia and industry. Since its first launch in China in mid 1990s, BPR was soon familiar to the internal corporations along with the popularity of ERP in less than ten years.

BPR is a very controversial topic in management literature. Despite isolated success stories at several firms, many organizations have encountered serious problems during their BPR implementations [1]. While BPR supporters claim that BPR is the only way to gain competitiveness and will lead to the reconstructed revolution instead of the industrial revolution, the discommenders bring forward the disappointed results of BPR efforts that the failure rates are as high as 70% [2]. Various reasons for this have been given in the past research. As William J. Kettinger

said “like most new managerial innovations, reengineering experienced an initial period of chaotic “trial and error,” with a lack of accepted methods”, one of the major problems in many BPR efforts is lacking of a disciplined method to model business process [3] and the BPR implementation always without a proper method supporting systematic redesign [4] [5].

So, is there a BPR implementation method that can enhance the success rate? Many experts and scholars have explored on this way for many years and have summarized some useful models, but the process of implementing BPR is still incomplete and fragmented in past literature [6]. Some worlds leading reengineering consulting firms, such as ISS, DMR Group, Andersen Consulting, Mckinsey C., all make use of their own proprietary BPR methods and experience to fulfill their clients’ unique needs. But they have not further summarized their useful treasures. Besides, they lack enough theoretical proofs to support the correctness of their methods. Thus, even given the plethora of BPR consulting services now available, there has not been a study placing these methodologies, techniques and tools into a classification framework permitting project planners to assess the “fit” between their unique organizational problem situations and available tools [7].

So, in this paper we will propose a new BPR implementation method which is feasible both in theory and practice by combining previous academic outcomes and practical experience in consulting companies. Also, commonly used BPR techniques and tools are mapped to each implementing stage. Especially, the efficiency and correctness of the implementation methodology has been validated and checked by a practical BPR project of KK Company.

II. Literature Review

To put BPR into action, methodological choices play a key role for the success of BPR [6]. In BPR literature, Many BPR implementation methods have put forward to fill the void of the critical mass of BPR projects, e.g. Wastell et. Al, G. White , 1996 [8]; Hammer, champy, 1993 [9]; Kettinger et al., 1997 [7], etc.. Table 1 summarized several typical implementing methods [7] [9] [10] in BPR literature in terms of the stages and activities included. As usual, BPR project can be implemented in three stages according to the domestic and international BPR project experience [11]. It is the simplest reengineering method among them while the

six-stage mode is the most complicated one. The composite stage-activity methodology based on the descriptions of 25 BPR methodologies derived by Kettinger et al. (2001) helps

the leading BPR project planners come out of the confusion of various reengineering methods choice [6].

Table 1 Representative methodologies, stages and activities

Methodology	Stages and activities					
Simple three-step mode	Categorize process <ul style="list-style-type: none"> • Categorize the process into three main sorts using value chain analysis: core process, boost up process, and sustaining process 	Analyze process <ul style="list-style-type: none"> • Identify improvement space of the candidate process • four indicators: cost, elapsed time, service quality, and performance influence 	Reorganize <ul style="list-style-type: none"> • Form implementing team • Reorganize • Dynamic evaluation and improvement 			
Four-step mode (Michael Hammer, Champy, 1993)	Make an agreement <ul style="list-style-type: none"> • Gaining top managers' support • Develop vision • Form BPR team • discover redesigning opportunities 	Analyze the business process <ul style="list-style-type: none"> • Analyze current process • Identify external demands • Define improvement objectives 	Redesign the process <ul style="list-style-type: none"> • Identify alternative solutions • Develop prototype • Create detailed design of system functions 	Implement business process <ul style="list-style-type: none"> • Implement infrastructure changes • Train employees • Perform process and system intergradations • evaluation 		
Five-step mode (Peppard J. Rowland P., 1998)	Build business condition <ul style="list-style-type: none"> • Develop business vision • Win top managers' support • Form a plan • Develop train • Identify core processes • Form BPR team • Develop vision 	Process diagnosis and redesign <ul style="list-style-type: none"> • Train BPR team • Diagnose current process • Diagnose current conditions • Benchmark • Design new process • identify redesign solution 	Redesign organizational structure <ul style="list-style-type: none"> • Examine the human resource • Examine the technical structure and abilities of employees • Redesign human resource structure • Redefine posts and train employees • Transpose labor into new process • Establish new IT infrastructure and application 	Implement pilot <ul style="list-style-type: none"> • Choose pilot • Form pilot team • Confirm the customers and suppliers involved • Run, monitor and support the pilot • Examine and collect feedback • Identify transform order and implement step by step 	Realize business vision <ul style="list-style-type: none"> • Evaluate performance • Make the benefits and efficiency apperceived by clients • Dig for more efficiency • Improve continuously 	
Six-step mode (Kettinger et al., 2001)	Envision <ul style="list-style-type: none"> • Establishing management commitment & vision • Discover reengineering opportunities • Identify IT level • Select process 	Initiate <ul style="list-style-type: none"> • Inform stakeholders • Organizing reengineering teams • Conduct project plan • Determine external process of customer requirements • Set performance goal 	Diagnose <ul style="list-style-type: none"> • Documentation of current process • Analyze existing process 	Redesign <ul style="list-style-type: none"> • Define and analyze new process concepts • Prototype and detailed design of a new process • Design human resource structure • Analyze and design IS 	Reconstruct <ul style="list-style-type: none"> • Reorganize • Implement IS • Train users • Process cut-over 	Evaluation <ul style="list-style-type: none"> • Evaluate process performance • Link to continuous improvement programs

The BPR implementation methodologies outlined in table 1 have their own specialties and properties. The three-step methodology is very consistent with its tools, and its evaluation standard is quite effective for its simpleness. So it quite suits the situation that the project has clear objectives and time limited. The four-step methodology is applicable to the common situations, i.e. if the project is some urgent, it can flexibly choose implementation approach and tools to reduce the time needed, or if the time is enough but the objectives are not very clear, it can choose corresponding implementation approach to identify the final aim in a longish period. The five and six steps methodologies are relatively mature and they are both suitable for the project which has undefined aim but with enough project time since they have a very detailed approach and its result is always perfect. However, all the methodologies have some fatal weaknesses. For example, the three-step methodology is

only for the project which has definite demands and specific evaluation index, and if the demand of the company is not systemic, the whole results will run in the opposite direction. Though the four-step methodology is mature, it emphasizes particularly on theory and its implementation approach. It ignores the real demands and the people in the company. Lacking the support of people and without agreement on the project results will lead to failure in practice. The five-step and six-step methodologies have the similar problem with the four-step methodology. They totally ignore the people in BPR implementation. Even though they have noticed gaining the support of top leaders, they overlook the demand of the staffers. Besides, they don't have a definite approach to solve the compatibility between the new process and the existing process which is also a factor results in failure. Finally, the five and six steps methodologies have long period of project schedule which will increase the

investment and aggravate company's burden.

In conclusion, we summarize the following evaluation sheet of the above BPR implementation methodologies by considering several basic BPR principles (see table 2).

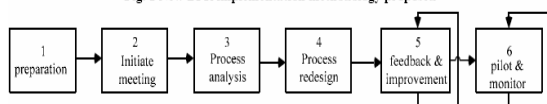
Table 2 BPR implementation methodology evaluation model

Basic Principles of BPR	Three-step mode	Four-step mode	Five-step mode	Six-step mode
Clear targets	Bad	Good	Excellent	Excellent
Extent focused on IT	Bad	bad	Excellent	Excellent
Reliability of project team	Bad	Good	Good	Good
Evaluation standard of project results	Good	Bad	Excellent	Excellent
Top managers' support	Bad	Good	Excellent	Good
Reduce the resistance from the people involved	Bad	Bad	High	Bad
Resistance from internal company	High	General	General	General
Choice of candidate processes	Excellent	Excellent	Good	Excellent
Solve the problem of compatibility	Bad	Bad	Bad	Bad
Pilot process	Bad	Bad	Excellent	Bad
Time needed	Short	Moderate	Long	Long
Feasibility	Bad	Bad	Good	Good
Continuous improvement	Bad	Bad	Good	Excellent

III. A Project-Based BPR Implementation Methodology

Is there a BPR implementation methodology which can not only gain the support of the whole company, but also can ensure the implementation quality as well as be time flexibility? With these questions in mind, we try to propose a BPR implementation methodology that can satisfy these requirements. By synthetically considering the pros and cons of the previous methodologies and referencing to the practical experience of several famous consulting firms, we put forward a new six-stage BPR implementation methodology which had been taken into action in the BPR project of KK Company (See Fig.1).

Fig. 1 New BPR implementation methodology proposed



Preparation

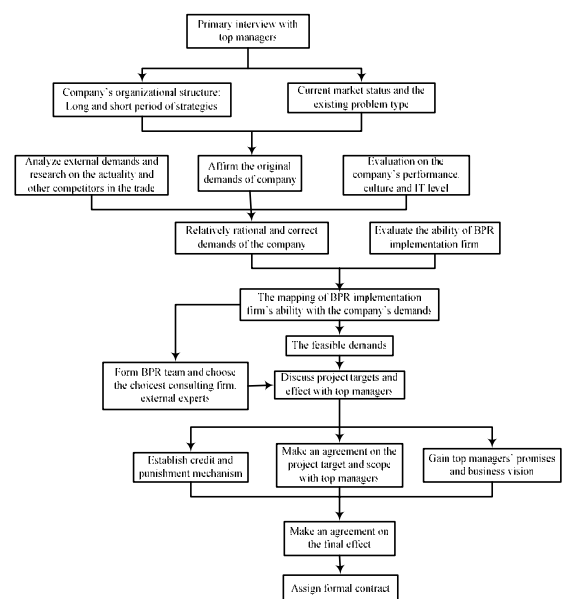
Before the start of BPR project, some prophase preparation should be done, such as collecting the basic information and demands of its client. Only if the client has the belief that the BPR consulting firm has truly understood its problems and requirements, it will be interested in further communication. Otherwise, it will not engage the firm to do the project. Accordingly, the implementation firm can also evaluate if its resource may meet the client's requirements correctly. Only with plenary capability can the BPR consulting firm ensure the quality of the project.

Another task in the preparation stage is winning top managers' support. As BPR is a long strategic innovation which has a far-reaching influence on the company, the top

managers' understanding seems so critical to the successful of the project. In this stage, BPR team should make the top manager fully understand the importance and necessary of BPR, and be on to BPR is an inevitable direction that the success has direct relationship with his own career development. On this precondition, we can remove their uneasy caused by the change of management process and their resistance to the reformation of human resource. If the top managers are eager to the success of BPR instead of embarrassing it, they will delegate power to the BPR team and support their work. The agreement on the aim, business vision, and final effect of the BPR project is also necessary other than winning the trust of top managers. BPR is not a heal-all and its effect can't appear immediately. Therefore, the agreement on the effect and vision of BPR project is propitious to the fair evaluation of the BPR effect made by top managers latter. Certainly, the top managers we have mentioned here must be the one has absolute authority in the company who own the final Power to make decision of the BPR project.

Table 3 summarized the main targets, needful information, expected results, and the tools and techniques available in this stage. The detailed implementation approach is also displayed in Fig. 2.

Fig. 2 detailed approaches in preparation stage



Initiate Meeting

Initiate meeting is very important in BPR implementation. It's the first meet between project members and the company members involved. There are several important tasks in this meeting including interpreting the cause and targets of the project, propagandizing the foreground of BPR, representing the detailed implementing methodology and approach, lessening the resistance of related people and winning support, and establishing the reliability of the BPR team.

During BPR implementation, the most pivotal factor is

people. Whether the employees in the company support BPR and are willing to provide relevant information is of great

importance. It is dangerous to implement BPR without

Table 3 summarization of the preparation stage

Main targets	Input information	Expected results	Tools and techniques
<ul style="list-style-type: none"> ◇ Win the support of top managers ◇ make agreement on the final effect of BPR ◇ Form BPR team and subscribe contract 	<ul style="list-style-type: none"> • Organizational structure • Long and short periods of strategic target • Type of currently encountered problem, e.g. the change of government's policies or competitors' strategies. • Current demands, e.g. for survive, develop or expand? • Company's market status • External demands of the Co. • Evaluation of the company's performance, culture, and IT level • Researches on trade actuality, e.g. surveys on competitors, suppliers, partners and customers • The mapping of the ability of BPR implementation firms with the demands of company • Basic research on other companies 	<ul style="list-style-type: none"> • Make an agreement on final project effect • Assign reengineering team • Choicest consultants and external experts • Gain the promises and business vision of top managers • Make an agreement on the scope and targets with top managers • Win support of top managers • Establish credit and punishment mechanism • Assign the formal contract 	<ul style="list-style-type: none"> • Fast Cycle Full Participation Change Methods • Search Conference • Visioning • Persuasion Technique • Team-Building Techniques • Project Scheduling Techniques

Table 4 summarization of the initial meeting stage

Main targets	Main participants	Prepared materials	Tools and Techniques
<ul style="list-style-type: none"> ◇ Inform the project planning ◇ Reduce the resistance of project Establish reliability of the implementation team 	<ul style="list-style-type: none"> • Top leaders who supervise the project directly • Middle-level or top managers who participate in the project directly • The indirectly participant managers or employee deputies who can provide information or suggestions • Employee representations who have influence on and can communicate with other employees 	<ul style="list-style-type: none"> • Company's background analysis • Company's strategic aim • Company's capability analysis • Trade's actuality analysis • Competitor analysis • Description of main problems • Importance and urgency of main problem • Project targets and expectant result analysis • Implementation approach of project • Schedule of project • Introduction of team members 	<ul style="list-style-type: none"> • Fast Cycle Full Participation Change Methods • Search Conference • Persuasion Technique

sufficient support of employees. Therefore, the importance of initiate meeting in BPR project can't be ignored.

The BPR consulting firm should inspire the related people of the company with proper exciting methods, such as putting forward the fascinating foreground of BPR and reasonable reengineering approach. By this way, employees can understand that BPR can bring continuous development to the company and also benefits to himself indirectly. Thereby, the inimical psychology of the employees who are afraid of the short-term loss caused by reengineering can be lessened. Besides, top managers' support and delegation can also remove the BPR objectors' gaingiving and can make for the following work greatly.

Finally, the self-introductions of the team members in this initial meeting can set up the team's prestige and trust by making all the employees know each team member's ability and specialty, which is of great benefit to solve problems during the reengineering implementation.

In table 4 we have summarized the main participants in the initial meeting, as well as the materials prepared beforehand and usable tools and techniques in this stage. Also, the detailed approaches are presented in Fig. 3.

Process Analysis

The next stage is describing and analyzing current process after the initial meeting. Company always has its own written process and the posts for running the process.

Therefore, BPR implementation team should understand and summarize the written process and its corresponding posts. After that, team members need to arrange a meeting with the charges in the company for further communication and try to find out the difference between the process in action and the process in documentation, and the reason for it. The profound understanding about current process will provide the team members with feasible and innovative ideas for the process redesign.

On the basis of understanding current process, team members have to find out which process should be improved. The feasibility of improvement must be analyzed carefully and the impossible ones should be eliminated. Afterwards, the importance of the candidate processes need to be sorted for solving the most important problem with the limited resources and promoting the competitiveness of the company furthest.

The main targets, needful information, expected results, useful tools and techniques are indicated in table 5 as well as the detailed approaches presented in Fig.4

Process Redesign

In this stage, a new process which should meet strategic objectives and operable is developed as well as corresponding organizational structure, IS and social system. Firstly, the principles and benchmark of BPR should be reaffirmed with the top leaders in the company, because BPR

principle and benchmark varies with different companies and different targets. For example, if A Company pursues quick response ability and B Company pursues high precision of the process not response ability of process, then even the same project team will adopt different methods. Certainly, the new processes designed are different. Afterwards, BPR team has to further analyze the improve space of process and carry through the process redesign by using innovative ideation and advanced reengineering techniques.

Hereon, the fundamental of business reengineering -- ESCRI can be utilized. Namely, Eliminate: eliminate needless functions and no value-adding activities; Simplify: simplify the complicated process; Combine: consider combining the irrevocable tasks; Rearrange: whether the order of tasks can be rearranged; Increase: increase the functions needed but have not been in existence.

The main targets, needful information, expected results, and useful tools and techniques are also summarized in table 6 as well as the detailed approaches of this stage presented in Fig. 5.

Fig. 3 detailed approaches in initial meeting stage

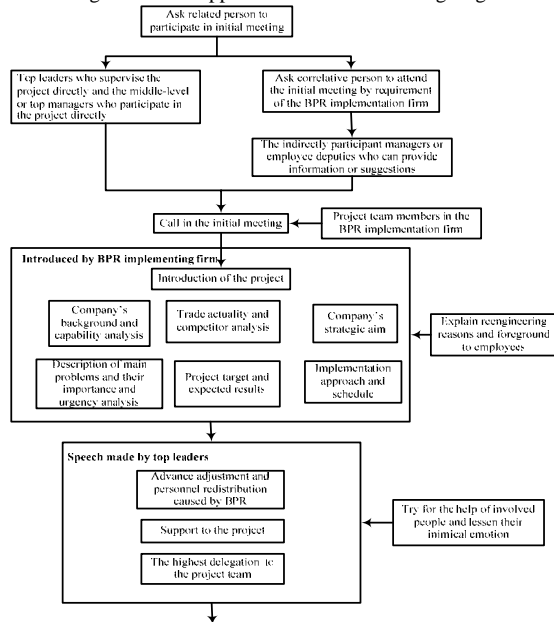


Fig.4 detailed approaches in process analysis stage

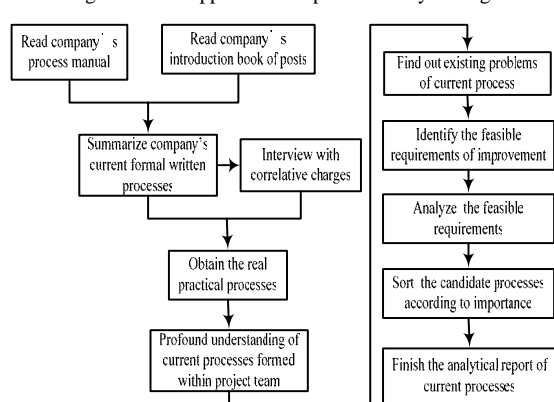


Fig. 5 detailed approaches in process redesign stage

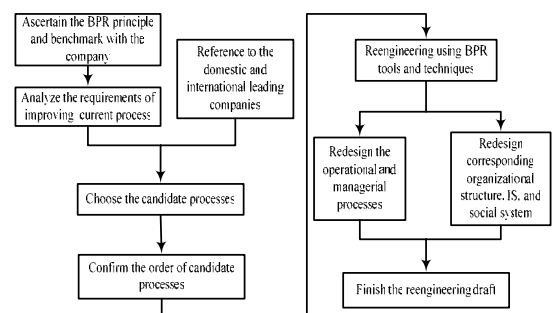
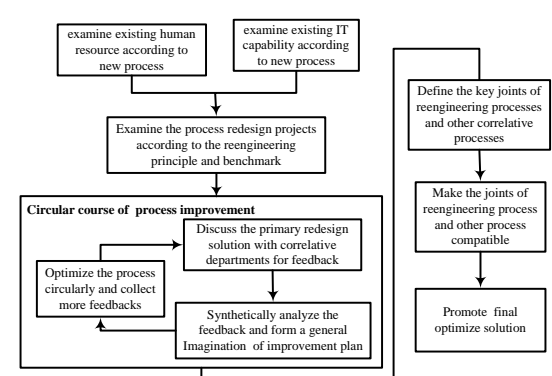


Fig. 6 detailed approaches in the evaluation stage



Feedback & Improvement

The elementary checkout and melioration of the new designed process should be done in this stage. BPR team will estimate whether the new process fits well with the company's manpower and technical level, and achieves expectant targets. Then, according to the real condition, the preliminary revise solution should be developed and be checked in terms of BPR principles and benchmark. Whereafter, the following steps should be repeated by 3 or 4 times.

- 1) document the revised process and distribute the documentation to the related people in the company
- 2) the project team members make an interview with related directors and all the managers in the company to collect feedbacks
- 3) Collection and analyze of feedback and identify valuable ideas which will be used to optimize the new process once again.

After tree or four times' repeat, project team should find out and check the compatibility of the pivotal joints of the new processes and the existing processes. The final process optimization is finished after solving the problem of compatibility.

Table 7 summarizes the main targets, needful information, expected results as well as the available tools and techniques, and Fig. 6 presents the detailed approaches of this stage.

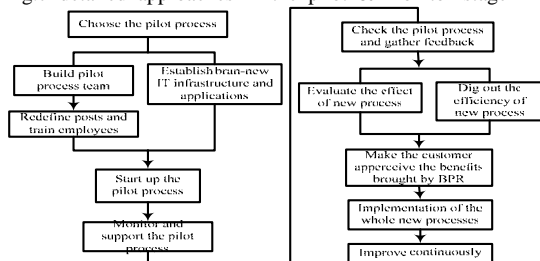
Pilot & Monitor

How to put the new process into action is an important question after advancing the final BPR solution. Usually, the

project team has to choose a pilot process from the reengineered processes. Given the urgency, the pilot process should be the one that has the least changes of posts and the employee training can be finished in short periods. Besides, the IT structure and applications needed for running the pilot can be set up quickly. Once the pilot process has been chosen, the project team starts to go about forming a pilot team, defining posts, training employees, and designing new technical platform. During the pilot experiment, the pilot team should monitor its status as well as its backup process, and collect feedbacks. Making use of the pilot, the effect of the new process can be evaluated and its efficiency can be further spotted. Furthermore, the client also can apperceive the benefits brought by BPR and be confident of the implementation of all the new processes. Thus, the whole new processes can put into action and be further ameliorated if the pilot process rolls one's hoop.

The main targets, expect results, and tools and techniques available in this stage are summarized in table 8 and detailed approaches are presented in Fig. 7.

Fig.7 detailed approaches in the pilot & monitor stage



IV. Discussions Based On a Hands on Project

Project Background

KK Co. is one of the leading companies in domestic household appliances trades. Its products such as DVD, telephone, language repeater and so on have been dominant in market. In order to making the most of its previous customer base, brand priority and channel management, KK Company launches new product ranges continuously for further development. Recently, KK Co. has launched a series of middle-level products, and prepares to promote the sales of them in next phase. It wants to become a leading company in domestic mini-music center market by further consummate its product structure. In order to be better customer orientated, the company engaged a consulting firm to reorganize the process of new product development and marketization for solving the current profit bottleneck ASAP. In sum, KK Co. wants to improve the following aspects.

- 1) identify the demands of the target customers
- 2) develop vision of new products and annual plan
- 3) the basic way for improve new product design
- 4) examine and approve the new products development

- 5) design and develop according to the concept of new product
- 6) identify the marketing and selling solutions
- 7) market popularize and track record analysis.

Discussion of the Project Results

This suit of new processes has been used by one of KK Company's new products—mini- acoustics. Employees in the company generally consider that the orientation of products is more accurate now. It has gotten rid of embarrassments caused by eyeless development and produce, and has been truly customer oriented.

The practice of the BPR project in KK Company has proved the feasibility of this innovative BPR implementation methodology which integrates both the distillate of previous BPR theories and the experience of the consulting companies. It assures the feasibility of implementation and the correctness of the BPR results by following innovative methods and steps:

- 1) understand the actuality and demands of the company clearly before the start of the project
- 2) definitely determine the targets of the project and its evaluation standards with the top managers of the company before the start of the project
- 3) win the support of the top managers of the company before the project starts
- 4) gain the support of the whole employees in the company at the initiate meeting
- 5) delegate power to the project team at the initiate meeting
- 6) choose appropriate analysis tools and methods according to the current condition of the company
- 7) choose proper reengineering solution on the basis of practical condition of the company
- 8) obtain continuous improved redesign solution by a closed loop of circular feedback
- 9) settle the contradictions and problems of new process by using the pilot

Though the time needed in this BPR methodology, it is quite feasible for some steps can be abridged or adjusted in different situations. For example, if the company has strong self-awareness and knows the direction of BPR and evaluation method clearly but with an urgent time requirement, then the first, second and the fifth step can be eliminated, besides, the step of running the pilot in the sixth step can also be eliminated if time limited. Thus, the BPR implementation methodology is similar with the simple three-step mode recommended before. The implementation is quick as the convenient and simple steps. Using the model introduced before (see table 2) to evaluate this new BPR implementation methodology. We will have the following table (table 9).

V. Conclusion

Nowadays, there are numerous theories and methodologies in management science, but have few revolutionary ones, while BPR is an outstanding one among them. Many enterprises win great success by business process reengineering. However, the high rate of failure indicates the huge risks in BPR implementation. The failure of BPR usually leads to quite turbulence of the company, some time even collapse. But it is a crag-fast situation that if doesn't carry out BPR the rigescent company will also be devoured by rivals in the competitive market. Various BPR implementation methodologies have been put forward by scholars which aim at enhance the success rate of BPR. But many of them are incomplete and lake of practical experience. However, the implementation methodologies in the consulting firms which have plenty practical experience are always lack of systematization and theorization. The new model for implementing BPR advanced in this paper combines both previous valuable BPR theories and practical experience in the consulting firms. It has a strong theoretical and practical proof. Especially, it is quite forceful for its good production in the practical BPR project of KK Company. It is believed that if implementing the BPR according to this methodology and choosing proper implementation team, it will greatly enhance the success rate of BPR project. We hope that this new BPR implementation methodology will be supported and further perfect by researchers, who are interested in this domain, and have made a certain contributions for the revolution of modern enterprises.

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Table 5 summarization of the process analysis stage

Main targets	Input information	Expected results	Tools and techniques
<ul style="list-style-type: none"> Understand and describe current processes Find out the problems of current process 	<ul style="list-style-type: none"> Company's process manual The introduction book of the Company's posts Real processes described by correlative charges and their suggestions 	<ul style="list-style-type: none"> Documentation of company's processes Real processes of the company Requirements of process improvement Feasibility analysis of the candidate processes Importance analysis of the candidate processes Analytical report of current processes 	Core Process Analysis, Brainstorming, Competitive Analysis, Critical Success Factors, Delphi Technique, Cultural Assessment analysis, Nominal Group Technique, Value-Chain Analysis, Cost/Benefit/Risk Analysis, Process Prioritization Matrix, Activity-Based Costing, DFD, Process Flowcharting, Computer-Aided Software Engineering, IDEF0~3, Petri Net, Speech Interaction Modeling, Job Analysis, Survey, fishbone Analysis, Pareto Diagramming, Information Control Net, Assumption Surfacing, Out-of-the-Box Thinking, Role Activity Diagramming, Cause and Effect Diagramming, Business Systems Planning, Analytical Hierarchy Process, Cognitive mapping

Table 6 summarization of the redesign stage

Main targets	Input information	Expected results	Tools and techniques
<ul style="list-style-type: none"> Redesign the process by a certain standard 	<ul style="list-style-type: none"> The final reengineering requirements of the company The Processes in domestic and international leading companies Compare the advantages and disadvantages of different BPR modeling methodologies 	<ul style="list-style-type: none"> Principle and benchmark of BPR Process needed to be redesigned Redesign the candidate process Redesign the organization structure, IS, and social system 	Critical Success Factors, out-of-the-box Thinking, Cost/Benefit/Risk Analysis, Process Prioritization Matrix, Activity-Based Costing, DFD, Process Flowcharting, Computer-Aided Software Engineering, IDEF0~3, Petri Net, Speech Interaction Modeling, Delphi Technique, Job Analysis, Job Design, Team-Based Organizational Design, Software Reengineering, Database Design, Workflow Design, Benchmarking, Analytical Hierarchy Process, IS Systems Walkthrough, Information Control Net

Table 7 summarization of the evaluation stage

Main targets	Input information	Expected results	Tools and techniques
<ul style="list-style-type: none"> Optimize the new designed process Solve the problems of compatibility in the process joints 	<ul style="list-style-type: none"> The Structure and diathesis of the employees, the strategy of human resource department Company's IT level and strategy in IT dep. Acceptance and suggestions of managers of all ranks Pivotal joints of processes 	<ul style="list-style-type: none"> Processes which fit well with the strategies of human resource and IT Three or four alternative optimize solutions. Final optimize solution The illumination of the joints between the new process and old process 	Brainstorming, Out-of-the-Box Thinking, Analysis, Activity-Based Flowcharting, Engineering, IDEF0~3, Modeling, Delphi Technique, Design, Team-Based Organizational Design, Software Reengineering, Workflow Design, Business Systems Planning, Analytical Hierarchy Process, IS Walkthrough, Information Engineering

Table 8 summarization of the pilot & monitor stage

Main targets	Expected results	Tools and techniques
<ul style="list-style-type: none"> Run the pilot process Implement whole new processes Sustaining improvement of new processes 	<ul style="list-style-type: none"> Pilot reports (grading) Pilot evaluation report Implementation report of the improved process Implement evaluation of the improved process Sustaining improvement records 	<ul style="list-style-type: none"> Assumption Surfacing, Socio-Tech System Design, Team-Building Techniques, Skills Inventory Analysis, Instruction-Based Training, Exploratory Training Methods, Activity-Based Costing, Auditing, Time Motion Study, Survey, Fishbone Analysis, Statistical Process Control, Instructed Interview, Pareto Diagramming, Total Quality Management Programs, Value Analysis, Quality Function Development, Role Playing, Focus Group, System Testing Technique, Effect Factor Analysis, Visioning

Table 9 Evaluation model of the new proposed

BPR implementation methodology

Basic Principles	New BPR implementation methodology proposed
Clear reengineering targets	Excellent
Extent focused on IT	Excellent
Reliability of project team	Excellent
Proper evaluation standards	Excellent
Top managers' support	Excellent
Reduce the resistance of related person	Excellent
Resistance in internal company	low
Choice of the candidate processes	Excellent
Solve the problem of compatibility	Excellent
pilot process	Excellent
Time needed	elastic
Feasibility of the implementation	Excellent

Modeling Business Process: Analysis of Goal-Oriented Approaches

Zhi Zheng, De-li Yang, Hong Yang

System Engineering Research Institute, Dalian University of Technology, P.R.China, 116024

TELEPHONE: 041182982229,13500989697

EMAIL: dafma@126.com

Abstract: A crucial management issue for most corporations is the effective design and implementation of their business process. However, existing approaches describe an enterprise in terms of activities and tasks view without offering sufficient guidance towards a process-centric description of the organization.

Goals have long been recognized to be essential components involved in the business process. Business process engineering research has increasingly recognized the leading role played by goals in the business process. Such recognition has led to a whole stream of research on goal-oriented approaches. The study of goal-oriented methodologies indicates that modeling of organizational goals constitutes a central activity of the business process.

In this paper we advocate the use of goal-oriented approaches to business process modeling. Some systematic approaches to developing and documenting business processes on the basis of the explicit or implicit business objectives are discussed. From the representation view of model, the way that models are expressed is demonstrated.

Keywords: Business process modeling, Goal-oriented approaches, Representation

I. Introduction

The traditional practice of managing an enterprise adopts a functional view in which the business is organized along individual types of work performed, resulting in organizational structures which reflect the particular functional view adopted by the business. The main reason for adopting a functional organization is the achievement of maximum performance of individuals or business functions. Nevertheless, this inward focus 'internal' performance rather than 'global' efficiency suffers from a number of drawbacks, especially when business improvement is sought. In particular, improvements occur piecemeal and independently of one another, while concentration on the symptoms of one function ignores causes in important cross-functional interdependency.

Current business challenges such as deregulation, mergers, globalization and increased competition, have given rise to a new philosophy of business management that organizes an enterprise in terms of processes rather than functional and tasks. The basic characteristic of this approach is the re-orientation of business from performing

as a cluster of functions or divisions to integrating activities within a limited number of core processes. Each core process captures cross-functional interdependencies and concentrates on few strategic objectives that determine competitive success. Therefore, a process-centric approach links improvement efforts in different functions to a shared set of strategic objectives.

Adopting a process view however, requires suitable tools for identifying, modeling and measuring business processes. Existing business modeling approaches describe enterprise in term of activities and tasks offering little or no guidance towards a process-centric description of the organization. In this paper we advocate the use of the goal-oriented approach whereby a business is seen as a purposeful system aiming to achieve defined objectives which add value to its customers.

The paper is organized as follows. Section2 introduces the notion of business process in term of its defining characteristics and presents a critique of existing process modeling techniques. Section3 briefly introduces some goal-oriented approach to business process modeling. Section4 discusses the relation between the existing goal-oriented approaches. In addition, from the representation view, the way that models are expressed is demonstrated. Finally, section 5 concludes goal-oriented approaches can be used by an enterprise that wishes to develop a new business process, or alternatively model, document and analyze an existing process.

II. Business Process Modeling

The concept of business process is a key issue in the process-centric paradigm. However, there is a considerable controversy around the numbers and types of process appropriate to a given organization [33]. The difficulty derives from the fact that there exists no explicit way for determining business processes. There is a lack of a coherent and universally accepted definition of business process definition of what a business process actually is. Nevertheless, there are some common features of business processes should be defined in the literature [33] [28] [24] [27] that provide guidance as to how business process should be defined. In summary a business process in the process-centric organization demonstrate the following characteristics.

- A business process has well identified products and customers, such that business objectives are matched through the (product offering) business process and delivered in form of the product; customers may be external or internal to the organization; products may

include finished goods or services

- A business process has goals, i.e., it is intended to achieve defined business objectives aiming to create value to customers
- A business process involves several activities which collectively achieve defined business process goals and create value to customers
- A business process crosses functional and organizational boundaries; it concerns the collaboration between organizational actors that are contributing to (or constraining) the satisfying of business objectives

In these terms a business process constitutes the manifestation of what organizational actors do in order to achieve business objectives. Organizational actors include individuals or groups which may be internal or external to the organization (e.g., company employees, organizational departments, customers, suppliers etc.) and influence the realization of business objectives. Business objectives aim at creating value to customers in other words they concern customer value goals.

Business process modeling is a generic name that refers to a collection of techniques which are used to model the behavior of business systems. Existing process modeling approaches mainly originate from the software engineering field and fall in one of three categories:

- Activity-oriented approaches describe a process as a set of ordered activities (SADT[7], IDEF0[18], DFD[34], Workflows[22], the F3 process[19]). The emphasis is on what activities take place. Each of these activities is decomposed in smaller tasks corresponding to smaller steps in the process. In addition to a collection of tasks activity-oriented models define the order of task invocation or condition(s) under which tasks must be invoked, task synchronization, and information flow.
- Agent-oriented (or role-oriented) approaches specify and analyze the role of the agents that participate in the process (e.g., Role Activity Diagrams[27]), Role Interaction Nets[4], the ORDIT approach[21]). The focus is on the entity that performs a process element. Roles represent the sequences activities carried out by agent engaged in a co-operative behavior.
- Product-oriented approaches represent a process through the evolution of its product (e.g., [31], [23]). Product-oriented models do not put forward the activities involved in a process but rather the result of these activities. The focus is on products and transformations made on them. Each product entity has a defined a sequence of states and triggers that cause state transformations.

All the above approaches promote a view of a process that is based on the notion of activity. Activity-oriented approaches focus solely on description of activities. In addition to product-oriented approaches couple activities to their output (the product), while agent-oriented approaches establish an explicit link between the activities and the agent

responsible for these activities.

Existing approaches offer little guidance for identifying business processes. In activity-oriented approaches the main mechanism for grouping activities into processes is that of composition/decomposition. This mechanism however, does not offer a unique way to identify a process. The difficulty derives from the fact that processes are almost indefinitely divisible; the activities involved in fulfilling a customer order, for example, can be viewed as one process or hundreds. Agent-oriented approaches on the other hand, group activities into processes according to the organizational agent that performs these activities. Yet a process may cut across the organization involving several organizational agents. Finally, product-oriented approaches group activities based on the product that they manipulate and this notion of a process is in accordance with the suggested business process definition as the delivering of products to customers. However this focus on product rather than organizational behavior fails to describe other important components of a business process such as the business goals the process intends to achieve and the collaboration of the agents that contribute to realization of process goals[9].

III. Goal-Oriented Approaches to Business Process Modeling

Business processes, unlike processes that are executed by machines, exist in social organizational settings. Organizations are made up of social actors who have goals and interests, which they pursue through a network of relationships with other actors. A richer model of a business process should therefore include not only how work products (entities) progress from process step to process step (activities), but also how the actors performing these steps relate to each other intentionally, i.e., in terms of concepts such as goal, belief, ability, and commitment. When an organization seeks new ways for organizing work, actors who have goals and interests are likely to evaluate these proposals strategically, e.g., in terms of potential opportunities and threats [11].

Therefore, it becomes obvious that taking a single modeling perspective (product, activity or role) is no sufficient for expressing business processes. A business process model is a description of the main constituents, purpose, processes, etc. of an organization and how they relate to each other. It is essentially a representation (on paper or on a computer) of the organization's knowledge about itself or what it would like to become. Here 'organization' can mean anything from a large corporation or government department to a small team or a one-man company. Similarly, the level of detail represented in the model can vary depending on its purpose[25]. As a result, a business enterprise is described as a network of related business processes which collaboratively realize business goals.

From the above analysis, goal plays an important role. This area has received increasing attention over the past few

years.

During the goal-oriented business process modeling approaches, EKD[9][30] is a systematic approach to developing and documenting enterprise knowledge, helping enterprise to consciously develop schemes for implementing changes. The approach is part of a larger enterprise knowledge modeling framework, known as the Enterprise Knowledge Development (EKD) approach. EKD advocates a goal-oriented view to business process modeling. Instead of imposing a single modeling criterion EKD offers a more general modeling framework that follows several modeling views (or rather modeling components), using the notion of business goals to structure business components in coherent business process. The above are summarized in Fig 1 which presents a concepts.

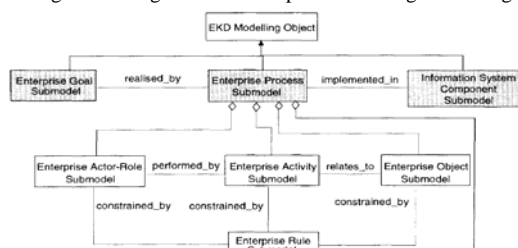
The EKD framework integrates three complementary views (submodels), namely: the enterprise goal view, the enterprise process view and the information systems components view.

The enterprise goal submodel uses a 'network' of goals that are used to express the casual structure of an enterprise, in terms of the goals-means relations from the 'intentional' objectives that control and govern the system operation to the actual 'physical' enterprise processes and activities available for achieving these objectives. The enterprises process submodel represents the organizational and behavioral aspects of an enterprise. An 'enterprise process' is a composite of four key enterprise components:(a)the roles that are played by enterprise actors in order to meet the process goals;(b)the activities involved in each role;(c)the objects that are involved together with their evolution from creation to extinction(within the context of the enterprise process);and(d) the rules that determine the process components. Finally, the information system component submodel focuses on the information systems components that support enterprise processes.

In using EKD modeling concepts one may start at any enterprise knowledge submodel (enterprise goals, processes or systems) and move to other levels, depending on the situation.

The totality of the EKD concepts form the enterprise knowledge ontology, i.e., the enterprise knowledge metamodel(EKM). This defines the logical form of the enterprise knowledge. The metamodel includes information about the semantics of the enterprise knowledge; it identifies the enterprise entities their attributes and explicit relationships between them.

Fig1 Modeling views in enterprise knowledge modeling



In addition to the above approach the i* framework (Distributed Intention, pronounced i-star) for modeling intentional, strategic actor relationships is another goal-oriented approach. The framework consists of two main components. The Strategic Dependency (SD) model describes a business organization in terms of the dependencies that actors have on each other in accomplishing their work. It is used to represent a particular design for a business process. The Strategic Rationale (SR) model provides a more detailed level of modeling by looking "inside" actors to model internal intentional relationships. Intentional elements (goals, tasks, resources, and softgoals) appear in SR models not only as external dependencies, but also as internal elements arranged into (mostly hierarchical) structures of means-ends, task-decompositions and contribution relationships.

Earlier versions of the framework has been presented in the context of requirements engineering [12], business process reengineering[13][14], software process modeling[15], and analysis of the organizational impact of computing[16]. Yu extends his earlier work by defining the features of the SR model and giving the highlights of its formalization. It also further clarifies how the framework assists in the understanding of business processes, and the generation and evaluation of alternatives.

The i* approach provides a description of work organization in terms of dependency relationships among actors. This approach acknowledges the fact that actors have freedom of action, within the social (inter-actor) constraints, called strategic dependencies. An actor is an active entity that carries out actions to achieve goals. Intentional components i.e., goals to be achieved, tasks to be accomplished, resources to be produced and softgoals (non-functional requirements) to be satisfied, are made specific embedded in the dependencies between actors [10].

In the goal-based workflow approach proposed in [5] an organization is seen as a tuple $[G, A, R]$ where G is a set of goals, A is a set of actors, and R is a set of resources. Actors act collaboratively using resources in order to attain their goals.

Similarly, Lee's Goal-based Process Analysis (GPA) is also goal-oriented approach[20]. GPA can be used to analyze existing processes in order to identify missing goals, ensure implementation of all goals, identify non-functional parts of a process, and explore alternatives to a given process.

The GEM model and methodology[3] is another goal-oriented approach of business process modeling. According to GEM business processes are collections of suitably ordered activities, enacted by individual persons, depending on their role within an organization. Every process has a purpose which is to achieve a goal or react to an event. GEM offers a number of models that can be used for specifying processes: the role interaction model, the purpose model, the procedure model, the internal data model and the corporate data model. The GEM methodology consists of three steps: defining the scope of the business process, doing process analysis and doing system design. The process analysis step

consists of the following stages: goal hierarchy analysis, basic procedure analysis, detailed procedure analysis, input/output data analysis and performance metrics specification.

IV. Discussion

The need for developing an overall view of goal concepts and goal-oriented approaches has also been argued in [17] and [2]. The former investigates the use of goal analysis in terms of different activities. On the other hand, the latter compares different goal-oriented methodologies on the basis of their goal modeling and specification approaches. In addition it provides an overview of different goal modeling strategies (goal refinement, goal decomposition, analogical reuse, goal operationalization, goal conflict management, and selection between alternatives). Rather than providing a comprehensive framework for analyzing the contribution of alternative approaches, the objective of these works has been mainly to stress the significance of goal concepts in business process and to draw the attention of the research community to goal-oriented business process. It also assists us to understand and accordingly select the best fit for goal-oriented modeling method.

For example, let us consider a BPR project concerning the reorganization of an electricity distribution company due to market deregulation. In order to meet the conditions in the competitive market the company needs to re-examine and improve the way of servicing its existing customers as well as to adopt new ways of working for servicing eligible customers. The implications of these forces on this organization is that any reform, requires, prior to (re-) designing business processes and support information systems, a clear understanding (and a sharing of this understanding between many stakeholders) of the current enterprise situation. Thus, a goal modeling approach such as the *i** strategic dependency modeling method or EKD, that focus on understanding the current organizational situation should be used [10].

We should also pay attention to other situational factors that affect the applicability of a method may include the use of appropriate tools that facilitate method execution and the familiarity of engineers with the applied strategies and supporting technologies. The selection of a particular method cannot be fully prescribed. Furthermore, even when one follows a certain goal-oriented modeling method the situational factors dominating the project may cause a number of adaptations to it.

Another observation is that additional benefits can be gained by integrating different methods. The combination of the two approaches can lead to a more complete methodology. An example of this type of integration is found in [8].

It should be noted that any type of integration should also take into consideration the system and representation views in order to ensure compatibility between different methods and consistency between the different goal representation formalisms. Initial analysis of the goal

concepts used in different approaches [1][29] shows that integration of goal models resulted from different methods is feasible, additional work is required however, in order to efficiently manage different formalisms and notations used in different approaches for expressing goal concepts.

From the representation view concern the way models are expressed. Models can be expressed in a variety of formats, using more or less formally defined notations. We differentiate between informal, semi-formal and formal approaches. Informal approaches generally use natural language text to express models; semi-formal use mostly box and arrow diagrams; finally, in formal approaches goals are expressed as logical assertions in some formal specification language [10].

In general, formal approaches use specification language to formally define model: Telos, Temporal Logic, Structured, Situation Calculus and ConGolog language, etc.

The vast majority of business process modeling efforts lack formal methods for modeling business processes. EKD uses entity-relationship models to represent structural information and Role-Activity Diagrams [26] to represent roles and their activities. EKD is a semi-formal approach.

*i** use the Telos language to formally define their models. The popularity of Telos is due to its ontological extensibility. This allows the capture of the semantics of one level at upper meta-levels inside Telos itself, thus allowing the definition of a customized conceptual language [32].

Rao [3] gives only a short informal description of the models and methodology. A methodology for developing multi-agent systems based on concepts similar to the ones in GEM appears in [6].

Semi-formal is the most widely used technique for model representation. Semi-formal models are imprecise in the sense that: (a) the meaning of modeling entities is described solely by the name given to it in the diagram and (b) the relationships between entities are loosely defined. Nevertheless, these models do provide an adequate basis for discussion between stakeholders and they also establish a framework for further analysis. Using these models stakeholders can confirm their shared view of the situation and agree the boundary within which a more detailed analysis will be performed.

Formal approaches offer more expressive languages and are therefore more amenable to formal reasoning. The main advantage of formal methods is that they can be used by sophisticated business analysts to capture business knowledge in an intuitive and unambiguous way. They can also be used to analyze processes in a formal way; this would have been impossible if the business analyst used an informal approach. However, they lack the freedom necessary to adequately support goal elicitation (e.g., to allow conflicts and inconsistencies among goals), and they lack the simplicity, flexibility and ease of use of semi-formal representations. Thus, semi-formal and formal representations are best seen as complementary contributing to an evolving framework for expressing models.

V. Conclusion

In this paper we have presented some typical goal-oriented approaches for modeling business process. In contrast to traditional business process modeling approaches which focus on business activities, the paper advocates the concept of business goal in order to describe the collaboration between business actors.

The paper has discussed some methodologies that enable business analysts to go from high-level enterprise objectives, to detailed and specifications of business processes for reasoning these objectives. The methodologies can be used by an enterprise that wishes to develop a new business process, or alternatively model, document and analyze an existing process.

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A Quality Evaluation of Internet Banking in Thailand

Panan Leelapongprasut*, Prasong Praneetpolgrang**, Natsapun Paopun***

*Master of Business Administration (Electronic Commerce)

Graduate School, Sripatum University

61 Phaholyothin Rd., Jatujak 10900, Bangkok, Thailand

Email: pnn_lee@yahoo.com

**Master of Science (Information Technology)

Graduate School, Sripatum University

61 Phaholyothin Rd., Jatujak 10900, Bangkok, Thailand

Email: prasong@spu.ac.th

***Master of Business Administration (Electronic Commerce)

Graduate School, Sripatum University

61 Phaholyothin Rd., Jatujak 10900, Bangkok, Thailand

Email: Natsapun@spu.ac.th

Abstract: The sampling groups in this research are customer who use the banking service via Internet system and the customer of D-Computer Co., Ltd. who usually use Internet Banking services such as inquiry about outstanding balance, fund transfer between accounts, and transfer payment for public utility. The sampling group specification of this research are must use Internet Banking services at least once a month. The research tools are questionnaires in the Web page form. Questionnaires are adapted from the tools that are used to evaluate the service quality called "The dimension of quality by David A. Garvin" by evaluating the quality of eight dimensional services: Performance, Features, Reliability, Conformance, Durability, Aesthetics, Serviceability and Perceived quality. During the sampling survey, we received 300 questionnaires that being answered completely. For information analysis, we use the fundamental statistics to analyze the characteristics of sampling group and test the relative variable factor by means of Chi-square and obtain the result to build a variance factor linear prototype.

The results were as follows:

1. The quality level of internet banking service of commercial banks in Thailand in the perspective of performance was different in each bank.
2. By weighting the important of criteria that used to evaluate the Internet Banking service quality in Thailand, the most important was the dimension of reliability, serviceability and durability. The less important was in dimension of perceived quality.

Keywords: Internet banking, e-Banking, service quality, dimension of quality.

I. Introduction

In the present days, internet consistently increases its importance as an effective communication channel providing unlimited, speedy and effective facilitation because of

its geographic advantage and low cost. Internet becomes well known and used in household, business, bank and government sectors. Leading commercial banks in our nation have developed their working system by introducing computer system into their operation for speedy operation, and elimination of documentation and document expenses.

In the early period, banks used computer to keep and gather the information on credit, savings and other office works. Later, Thai commercial banks have developed computer system to be modern and correspond to the changing circumstances. In the age of communication and information development, the speed of data access and more effective advantages enhance the step to e-banking.

From 12 commercial banks in Thailand now [1], only eight banks, namely, 1. Bangkok Bank Public Company Limited, 2. Krung Thai Bank Public Company Limited, 3. Bank of Ayudhya Public Company Limited, 4. Kasikorn Bank Public Company Limited, 5. TMB Bank Public Company Limited, 6. Bank Thai Public Company Limited, 7. The Siam Commercial Bank Public Company Limited and 8. Bank of Asia Public Company Limited, provide alike internet banking services. In fact, the internet banking system has been available for not less than 4 years by Bank of Asia Public Company Limited and The Siam Commercial Bank Public Company Limited as the pioneers [2].

Internet banking service is available 24 hours. Customers do not have to pay traveling charge to do any transaction because it is accessible via internet system from the user's house or office. However, internet banking service is less popular than counter service or call-center service but it shows the sign of continuous progress.

From the study conducted by Winnie Chung and John Paynter [3], the following 3 points of internet banking service should be considered as important, namely, security system, data update and responding period. What is found not important for the service is the animation. Worasri Tantichattanon [4] said that the main issues of the unpopularity of internet banking were the security system, unreliability and insecurity of the service whereas the factors creating the confidence of the users of internet banking service were the accurate data and good security system.

II. Conceptual Framework

The conceptual framework in this research is the study on the satisfaction of the customer of internet banking service. The quality of service is measured by the use The Eight Dimension of Quality by Garvin [5], namely, performance, features, reliability, conformance, durability, serviceability, aesthetics and perceived quality. These perspectives were transformed to be a questionnaire on a web page to measure the quality of service of internet banking in Thailand.

III. Research Methodology

The first part of the research is to evaluate eight Thailand banks regarding their Internet Banking services quality. This is an objective evaluation that aims to examine whether there is any difference among the eight Thailand banks. The Eight Dimension Quality was used as a basis for the evaluation in this part of the study.

Components that appear in the Eight Dimension Quality are performance, features, reliability, conformance, durability, serviceability, aesthetics and perceived quality. These components are the starting criteria that were used to evaluate the eight Thailand banks.

This dimension quality model (Table 1) was used to measure the services quality of each bank by presence of each element.

Table 1: The Eight Dimension Quality Model

Components	Elements
Performance	Up to date Information Response time Download time Complete Product Information Tutorial / Demonstration Help Function
Features	Online Registration Transfer funds between bank Other Language in addition to English Keep data safe Require encryption (SSL) 24 hours – 7 days Innovation features Ease of use
Reliability	Require Authentication Limit to change data Complete data Correct Link Manage font display

	Clear Instructions
Conformance	Product Information Locating Information How Informative Explains Symbol Internal Connection System Responsiveness
Durability	Announce change something Complete Display System Performance Continue to Use Connection failed Able to fix problem
Serviceability	Search Function Navigation menu / buttons Online Help Communication with Security Rapidly Services
Components	Elements
Aesthetics	Font Format Display Color Font Picture/Graphic/Animation Picture Size Layouts Color Theme
Perceived Quality	Company Information Competitions or rewards Development Basis of Honest Basis of Reliability Basis of acceptably

The second part of the research is a survey that aims to compare the overall services quality of Internet Banking and factor of Internet Banking service between each bank in Thailand and each dimension of quality by David A. Garvin.

The data in this research was gathered from the samplings of customers of internet banking of the eight banks of which the 2 main groups were users from D Computer Co., Ltd and general users of internet banking service in Thailand. In order to obtain comprehensive data as to the research objectives and the data accuracy, reliability, the qualifications of the samplings were set at the use regularity - or at least once a month.

During the sampling survey, we received 300 questionnaires that being answered completely. Quota sampling was used to select the samplings. Chi-square test and coefficient of correlation test were used to analyze the data. The result was brought to create Multiple Regression model to test the hypothesis.

IV. Preliminary Results

1. General information of samplings

Most of the samplings who were the users of internet banking service of the eight banks were female with the educational level of bachelor degree. The frequency of service use was 2-3 times a month. The ages of the samplings were between 21-30 years and their salary was less than 15,000 Baht a month.

2. Research hypothesis

2.1 The quality level of internet banking service of commercial banks in Thailand in the perspective of performance was different at the statistical significance of 0.5. For other perspectives, the quality level of each bank was not different at the statistical significance of 0.5.

2.2 The users of internet banking service gave importance to the eight perspectives of quality. The most importance one was the reliability, serviceability and durability respectively.

The least important perspective was perceived quality of the commercial bank.

V. Conclusion

From the study on the quality level of the internet banking service in Thailand, it was found that reliability, namely the security system and information accuracy, was the most important perspective for the user.

Comprehensively, reliability – the perspective which creates the reliability for the user - should be developed and improved for better performance. This would positively affect the commercial banks and lead to higher customer satisfaction.

The result of this research could be able to use as a guideline to setup a form of service in order to satisfy the needs of target group accurately and appropriately. Using as a database to set the market strategies in order to penetrate the target group efficiently, and also being use as a guideline to create a new form of service so that the users get more variety choices.

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A Last-Minute E-Auction for Hotel Rooms

Vatcharaporn Esichaikul Clemens Bechter Le Thi Nhan
Asian Institute of Technology, Thailand

Email: vatchara@ait.ac.th, bechter@ait.ac.th, lethi.nhan@ait.ac.th

Abstract: Electronic auctions have rapidly become one of the most widespread applications in electronic commerce. Within e-auctions, the online products are almost anything imaginable such as electronic parts, artwork, vacation packages, airline tickets, etc. In this paper, the reverse auction was implemented by proposing a suitable bidding mechanism for perishable products like hotel rooms. These vacant rooms should be sold as soon as possible before their value zeroes. Therefore, the Last-Minute Auction not only helps the buyers get their desired rooms, but also helps the hotels to selling their rooms in time. The research combined the Hungarian algorithm and Branch-and-Bound search to match the buyers' demand and the sellers' supply and optimizing the auction site's revenue.

Keywords: Hospitality Business and the Internet, Reverse auction, Last-minute auction, Hotel room.

I. Introduction

An electronic auction (e-Auction) plays an important role in online business world today. With e-Auction, suppliers can sell their products at a price that meets buyers' expectations, saving time, reducing costs, increasing revenues and acquiring more benefits as well. On the other hand, consumers have chances to bargain, buying goods and services at affordable price anytime and anywhere.

Travel products such as air tickets, hotel rooms, and car rentals are last minute commodities with a limited lifetime. That is why the supplier should sell or rent them as early as possible to induce more revenues. How does a supplier make a dynamic decision to sell products early enough to maximize revenues? Even more important, how do consumers get hold of their desired product at the low price?

A reverse auction is beneficial for both parties. From the customer's perspective, it offers lower prices combined with a broader supplier base and a more efficient procurement process. Online buyers can save money when purchasing goods through the online auction because the very nature of an auction tends to force suppliers to reduce asking price progressively, in sync with demand.

However, reverse auctions are better suited to only particular kinds of product such as high-volume bulk commodities, while they tend to become less advantageous for goods that are more specialized. An auction can hardly handle such issues as complex product specifications, because the more complicated is the item description, the higher turns to be the risk.

This paper aims to apply the mechanism of a reverse auction for sales of a last-minute product, such as hotel rooms. In addition, the paper proposes an appropriate mechanism needed for the last-minute auction in accordance with the increasing role that reverse auction plays in an electronic business nowadays.

II. Background on E-Auction in Travel Industry

In travel industry, all major airlines, vacation services, travel agencies, car rental agencies, hotels, and tour companies provide online services. Auctions and bids are also conducted online permitting customers to bid for a ticket, a hotel room, or a rental car. There are many online auction sites in travel industry. Among the two major sites are following:

II.1 Lastminute.com

Brent Hoberman and Martha Lane Fox (<http://www.lastminute.com>) founded lastminute.com in 1998. It has become Europe's leading online travel retailer offering lifestyle products as well as travel-related services. Based on the idea of matching supply and demand, it offers consumers last minute opportunities to acquire airline tickets, hotel rooms, package holidays, entertainment tickets, restaurant reservations, home delivery, services, gifts and auctions. At lastminute.com, buyers bid for goods or services of a certain vendor who may be lastminute.com or a third party using three auction formats: English Auction, Reserve-Price Auction and Dutch Auction.

II.2 Priceline.com

Founded in 1998, Priceline.com is a reverse auction site where buyers select products they want to buy and the price they are willing to pay. The goods and services for sale or rent include airline tickets, hotel rooms, cars, packaged vacations and cruises. Priceline.com provides one auction format - sealed-bid first-price format. First, the potential buyer selects the city and the date that he or she wants to stay. Next, the buyer selects the specific areas and the quality level of a hotel. Then the buyer names the maximum price that he or she is willing to pay. When the system reviews the request, the buyer enters their credit card information. After that, Priceline.com searches its database for available hotel rooms and when a matching room with the price lower than the asking bid price is found, the bid is accepted, buyer's credit card is charged for their asking price with applicable taxes, and the buyer gets the room.

III. Proposed Last-Minute E-Auction

In the proposed Last-Minute auction, there are four major components: 1) Registration; 2) Room Request Posting; 3) Hotel Bidding; and 4) Demand and Supply Matching.

III.1 Registration Component

This component permits a customer to register as a member of the system. After the registration process, a customer obtains a login name and a password to log in the system.

III.2 Room Request Posting

This component permits a customer to post a hotel room request. A customer can request hotel rooms by specifying the city name, an area in the city, desired hotel star rating, number of rooms, and the maximum rate per night. To complete a request, a customer must provide credit card information.

III.3 Hotel Bidding

This component forwards room requests to participating hotels and invites them to place a bid. For bidding, each hotel must supply the number of vacant rooms and room rate per night. When there is a lower bid, the system will notify

hotels asking whether they want to reduce their bids.

III.4 Demand and Supply Matching

This component will match customers' need providing the supply of the hotels. The matching process starts with summarizing all requests, according to criteria - city name, area, hotel star rating and specified room rates. After that, system sends all requests to relevant hotels inviting them to place their bids. All received bids from the hotels are summarized according to above criteria. Then customers' demands are matched with the supply of the hotels, which allows maximizing the revenue of the auction site. In case when a customer requests more than one room, a match ensures that all rooms requested by a customer are in the same hotel.

In the matching process, the system uses the Hungarian algorithm (see Figure 1) developed by Kuhn and Munkres (also known as Kuhn-Munkres algorithm). The problem is represented by a bipartite graph, $G(X, Y, X * Y)$, with weights $w(e_i)$ assigned to every edge. The set X represents buyer's room, and the set Y represents seller's room. The weight of an edge represents the mark-up money for a (buyer's room, seller's room) pair. The algorithm finds the matching with the greatest total weight.

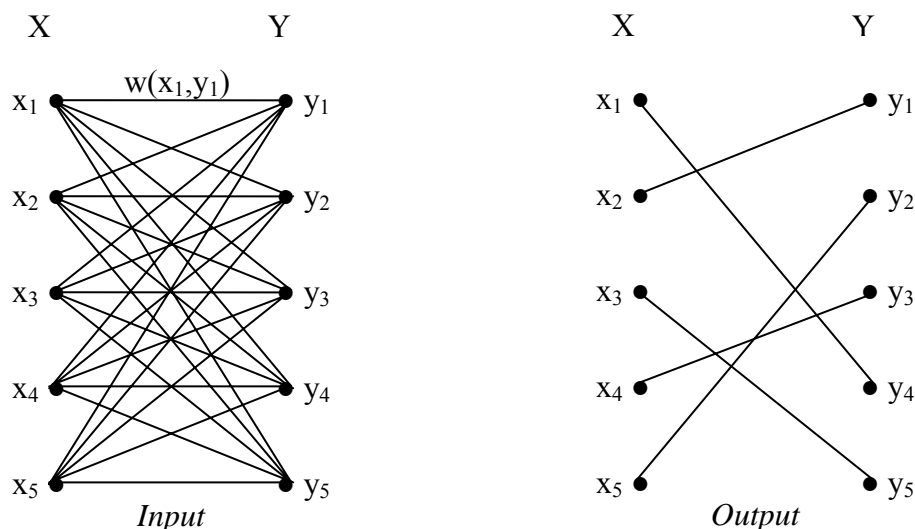


Figure 1: Hungarian Algorithm

An example of assignment problem and Hungarian method is outlined in the following matrix. The weight w_{ij} are the entries of an $n \times n$ matrix, and the elements of X and Y are

identified with the rows and columns of the matrix respectively. Let's assume that there are three requests named 1, 2, 3 and two hotels named 1, 2.

	H ₁	h ₂	h ₃	h ₄	h ₅
r ₁	7	2	1	9	4
r ₂	9	6	9	5	5
r ₃	3	8	3	1	8
r ₄	7	9	4	2	2
r ₅	8	4	7	4	8

The mark-up money between request₃ and hotel₂

Where:

- r₁ and r₂ are rooms of request₁
- r₃ is a room of request₂
- r₄ and r₅ are rooms of request₃

and

- h₁, h₂ and h₃ are rooms of hotel₁
- h₄ and h₅ are rooms of hotel₂

The optimal matching is shown in Figure 10 with the matches [r₁, h₄], [r₂, h₃], [r₃, h₅], [r₄, h₂], and [r₅, h₁]. The profit, 43, is the sum of these matches' weight.

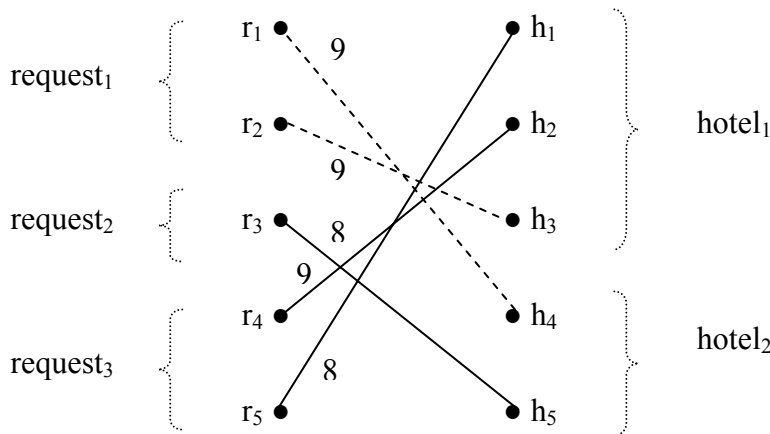


Figure 2: The Example of Hungarian Algorithm.

However, the requirement of current matching problem is more complex than the requirement of basic weighted matching. In the above example, the request₁ does not satisfy the requirements of the problem, because the request₁ is assigned to different hotels. Therefore, the result from Hungarian algorithm is not optimal but is acceptable as a temporary solution if all bad matches are being filtered. In the next step, we will use exhaustive search algorithm, particularly a Branch-and-Bound search, to get optimal solution. Using exhaustive search algorithm takes some time, so it will be formulated with the following conditions in order to quickly yield a solution.

- In the process of searching, the case that cannot yield the solution will be early eliminated.
- To get solution early, the exhaustive search algorithm has to choose the case having a better solution than the Hungarian algorithm's solution. Thus, the heuristic method will be used to implement the estimated profit function. In this function, the total

profit of all remained requests and supplies are calculated in advance. After that, the result of estimated profit function will be added to the current profit and compared with temporal solution, the lower bound from Hungarian method's solution.

Using exhaustive search, a customer's request may or may not be satisfied by hotels. Therefore, the type of exhaustive search where each node will be considered as a feasible solution.

IV. Prototype Implementation

The Last-Minute auction prototype is implemented based on the following technologies:

- Platform: Windows XP Professional is used as operating system at client side and Windows 2000 Advanced Server is used as operating system at server side.

- Web Server: Microsoft IIS 5.1 (Internet Information Service) is used to manage the website.
- Database Server: Microsoft SQL Server 8.0 is used to manage all the data of the auction.
- Software Development Tool: Microsoft Development Environment 7.1 and Microsoft .NET Framework 1.1 are used to develop the application. ASP.NET (Active Server Pages) is used as a technology to build the application.
- Aid Tool: Rose Enterprise Edition 2002.05.00 is utilized to analyze and design the application.

The interface of proposed Last-Minute auction is divided into three parts: customer interface, hotel interface and auction site administration interface.

V. Conclusion

The Last-Minute auction was designed and implemented for auctioning vacant hotel rooms. From the customers' perspective, its bidding mechanism permits them to specify their requirements and join the Last-Minute auction. From the sellers' perspective, the Last-Minute Auction helps them sell quickly vacant rooms with reasonable rates. Sellers or hotels can decrease their bids to compete successively with others and win the bids. For the auction site, the proposed mechanism helped them earn maximum revenue through the proper matching of customers' demand and hotels' supply.

The matching algorithm was designed to solve the complex problem of having many matching criteria, such as the same city, area, hotel star rating, number of room and rate. The combination of Hungarian algorithm and Branch-and-Bound search has yielded the accurate answer, which satisfied the requirements of the problem. Another solution for the weighted matching problem and the profit optimization, which has not been examined yet, is Genetic Algorithm. The solution generated by Genetic Algorithm can be a direction of the future work.

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A Comparative Analysis between SMEs and Large Companies in Relation to Integration Technologies Adoption

Miss Chen, Hsin *, Miss Wu Ching-Fang **

* Department of Information Systems, Mathematics & Computing,
Brunel University, UK Uxbridge, Middlesex UB8 3PH

Tel: 01895 274000 Fax: 01895 232806 Hsin.Chen@brunel.ac.uk

** Department of Business Administration, Yu Da College of Business, Taiwan
No168, Hsueh Fu Rd., Chao Chiao, Maio Li

Tel: 88637 651188 Fax: 88637 651216 Chingfangwu@yahoo.com.tw

Abstract: Integration technologies like Enterprise Application Integration (EAI) and Web Services allow organisations to collaborate with their partners, increase flexibility and gain competitive advantages. Despite the benefits that the integration of Information Systems (IS) can offer to enterprises, little attention has paid on the adoption of integration software by Small to Medium Sized Enterprises (SMEs). The body of literature suggests that the findings that derive from the study of large enterprises can not be generalised and applied in SMEs due to the nature and characteristics of SMEs. In an attempt to study this area, research questions were raised. These research questions are investigated in this paper and supported the authors to propose a research model. The proposed model might be used to explain why SMEs and large organisations take decisions for the adoption of integration technologies focusing on different factors. The results of an empirical study carried out on a sample of 102 companies of any size in Taiwan are presented, aiming at highlighting any significant difference in the way SMEs and large companies approach integration technologies.

Keywords: SMEs, Integration technologies, EAI, Web Services, Integration technologies adoption.

I. Introduction

Despite the advantages that IS integration can offer to organisations as mentioned in the literature, little attention has been paid to the adoption of integration technologies by SMEs [22][43]. Iacovou *et al.* [23] reported that SMEs differ from large companies in many ways that affect the adoption of integration technologies. These differences include: the lower levels of resources available for this [23] [28], the substantially less sophisticated IS management [25][43], the needs for integration and their characteristics, and the quantity and quality of the available environmental information [33]. For these reasons, Kuan and Chau [28], among others suggested that the general applicability of the studies in large organisations may be questionable if applied to small businesses. Thong [46] also argued that because of the unique characteristics of small businesses, there is a need

to examine whether those models for IS adoption developed for the large business context can be equally applied to small businesses.

Although the adoption of integration technologies is recognised in the normative literature as being different between large and small companies, the literature on the adoption of integration technologies by SMEs remains limited [28]. Nevertheless, among the existing works, their focus mostly emphasises on either the adoption decision or the successful implementation factors [9][28][38]. To the best of the authors' knowledge, there are no studies on the reasons why SMEs and large companies take the decision to adopt integration technologies, which focus specifically on the different factors. Thus, this presents a research issue which needs further investigation. This paper attempts to address this issue by studying the factors affecting the adoption of integration technologies by comparatively analysing the adoption factors between SMEs and large companies. The proposed research model is tested through a survey study in Taiwan IT industry (with 68 usable responses and 87% of the responding firms' integration technology users).

Therefore, this paper aims to identify the significant differences in the way that SMEs and large companies approach integration technologies. In doing so, the parameters are identified that can be used to explain the adoption of integration technologies between SMEs and large firms, which are the nature, company size, integration needs, adoption factors for SMEs and large organisations and time. It is argued that this paper is of value in highlighting the specific parameters in SMEs and large organisations in relation to integration technologies adoption.

II. Research Issues Analysis

II.1 Nature of Organisations

Globalisation forces many enterprises to change the way they do business. To compete in global markets, SMEs need to develop new business strategies and deploy new technologies. For example, Web Services and EAI are relatively new technologies. However, Storey [41] argued that the size of small businesses creates a special condition, which can be referred to as resource poverty, that distinguishes them from their larger counterparts and requires some different management approaches. Thus, it is

vital to identify the nature of SMEs to assess what makes them distinct from other types of organisation (e.g. large organisations), as the nature of SMEs might be a real obstacle to their adoption of integration technologies.

SMEs consist of a significant part of the economy and are characterised by high firm failure rates [42]. Storey and Cressy [41] reported that about 11% of small businesses fail to survive in any given year. This failure rate is six times higher for smaller than it is for larger businesses. This is due to SMEs usually:

- Having little ability to influence market price by altering their output [27].
- Having small market shares, so are unable to erect barriers to enter their industry [15].
- Can not easily raise prices and tend to be heavily dependent on a small number of customers [42].

Small businesses can not usually afford to pay for the kind of accounting and book keeping services they need, nor can their new employees be adequately tested and trained in advance [49]. Small businesses are also under increasing pressure to employ IS to maintain their competitive positions. At the same time, there are more barriers to IS implementation in small businesses than there are for large businesses, due to the high capital investment and skilled manpower involved in implementing and operating IS [47]. Welsh and White [49] also pointed out that resource constraints (time, finance and expertise) in small businesses are based on the concept of the resource-based theory. The resource-based theory is often used to explain the adoption and use of information systems and technology in SMEs. According to it, firms are characterised as being collectors of resources or capabilities. A firm's resources may include both tangible and intangible assets, including capabilities, organisational processes, information, and knowledge, that are all controlled by a firm to enable them to conceive and implement strategies that improve its efficiency and effectiveness [2]. The resource-based theory emphasises an understanding of the internal capabilities that enable organisations to secure competitive positions and the importance of internal resources in a company [2] [4]. In this research, the resource-based theory is applied to explain the importance of the natural resources of a company, in terms of the integration of their technologies adoption decision (e.g. time, finance and expertise constraints).

Time constraints refer to the limited amount of time available for activities beyond the normal job responsibilities of individuals in small businesses. Financial constraints refer to the limited amount of finance available for activities beyond the normal operations of the small businesses. Expertise constraints refer to the limited amount of expertise within the small businesses to carry out activities beyond their designated job responsibilities. Based on these, Welsh and White [49] reported that: (a) SMEs have to control their cash flows carefully, as they do not have unlimited funds for their IS project; (b) SMEs tend to choose the cheapest system, which may be inadequate for

their purposes; (c) SMEs usually underestimate the amount of time and effort required for adopting integration technologies; and (d) SMEs normally engage consultants and IT vendors to develop and support their information systems [47]. For example, SMEs might prefer to outsource most of their activities, whereas large companies might only prefer to outsource those activities which are not directly related to their business strategies, or even to manage these activities totally on their own.

Resources such as time, finance, and expertise that are all necessary for planning, represent the most critical difficulties for small businesses [10]. Due to this reason, Kagan *et al.*, [25] and Tagliavini *et al.*, [43] claimed that SMEs usually have substantially less management over their sophisticated information systems and that this might affect the way that they approach integration technologies. In addition, according to Attewell's [1] technology diffusion theory, it emphasises the role of external entities (e.g. consultants and IT vendors) as knowledge providers in lowering the knowledge barrier or knowledge deficiency on the parts of potential IS adopters. Small businesses tend to delay in-house IS implementation because they have insufficient knowledge to implement IS successfully [47].

Thus, based on the discussion in this section, it appears that the nature of SMEs, in terms of external and internal resources (e.g. time, finance and expertise), impacts on the way that they approach integration technologies. To this end, the following research question is raised for further investigation.

RQ1: *Is the nature of SMEs a real obstacle to integration technologies adoption.*

II. 2 Company Sizes

Apart from organisational or strategic remarks, various literature emphasises size as one of the issues that is increasing the need for the co-ordination and control of organisational activities [21][32][50]. Tagliavini *et al.* [43] proposed that company size is an important factor affecting ERP adoption. DeLone [16] also suggested that computer usage characteristics are different in organisations of different sizes. Other research works, like IDC's [24], suggest a direct relationship between the size of organisations and the percentage of those organisations in which ERP has been implemented. All these studies indicated that the size of the organisations have many different impacts on the ways that the organisations do things.

As reported in the literature, SMEs can be categorised as micro sized companies if they have up to 20 employees. SMEs can also be defined as small sized companies if they have up to 100 employees, whereas SMEs can be classified as being medium sized companies if they have up to 500 employees. Companies that have more than 500 employees can be seen as large organisations [11]. Company size is important, as a company with 20 employees and a company with 500 employees have different ways of managing their

IS. For example, the same system might be managed by 200 employees from the IT department in large companies, but only managed by 20 or less employees in small companies. In accordance with the views discussed here, the authors suggest that there is a possibility that companies of different sizes follow different approaches towards the adoption of integration technologies. Thus, company size is included here as a factor that affects the adoption of integration technologies.

In accordance with the views discussed in this section, the researcher suggests that it is possible that companies of different sizes may follow different approaches for their adoption of integration technologies. Thus, a research question is proposed for further investigation:

RQ2: *What is the relationship between integration technologies and their adoption in companies of different sizes?*

II. 3 Need for Integration

It was found that organisations adopt a new technology only if it provides significantly better benefits than their existing ones [39]. A new technology has to provide solutions for existing problems or open up new opportunities to motivate an organisation to take a proactive decision to adopt it with a trading partner. Although the organisational structure of larger organisations could be very different from SMEs, companies of any size show a critical need for the coordination and control of business activities [43]. Thus, it is important to understand organisations' motivations/needs for adopting a new technology.

According to the literature, the reasons that push large companies to turn to enterprise application integration, include among other things: (a) their Enterprise Resources Planning (ERP) systems cannot fully automate and integrate organisations since ERP coexists alongside other applications, (b) technical reasons, (c) financial reasons, (d) managerial reasons and (e) strategic reasons [45]. However, the authors found that the motivations mentioned by Themistocleous [45] are not appropriate to explain SMEs' need for integration. For example, some small firms might not even have ERP systems. Therefore, by reviewing the existing literature on the adoption of integration technologies by SMEs, a number of reasons that push SMEs to turn to integration technologies to support their IS have been identified. These reasons are explained as follows:

- **External Pressures:** External forces tend to have more impact on small businesses than they do on large businesses [23] [49]. In many cases, a company may adopt a technology due to the influences exerted by its business partners and/or its competitors, having no relation to the technology and organisation itself. For example, pressures from business partners or competitors have been found to be an important factor in the adoption of integration technologies [20] [28] [35]. Since SMEs are usually the weaker partners in inter-organisational relationships, small businesses are susceptible to impositions by their larger partners [40]. Therefore, SMEs

are under pressure to adopt integration technologies if its business partners request or recommend it to do so.

- **Internal Pressures:** Internal pressures include both the financial and technological resources of the firm. Financial resources are related to the financial resources available to pay for the integration technologies installation costs and for the implementation of any subsequent enhancements, as well as for ongoing expenses during usage. Technological resources refer to the level of sophistication of IT usage and IT management in an organisation. As mentioned before, SMEs need to control their cash flows carefully, as they do not have unlimited funds for their IS projects. Thus, smaller firms tend to choose the cheapest system which may be adequate for their purposes [47]. In addition, Thong [47] also reported that small businesses tend to have insufficient knowledge to implement IS successfully, thus, SMEs might need to seek external expertise (e.g. IT vendors etc.). These all indicate that SMEs' need for integration technologies might be based on their internal resources/pressures. Since SMEs are normally lacking in internal resources, when compared to large companies, it was thus argued that SMEs might make different adoption decisions than their larger counterparts [28].

- **Competition:** The main reason SMEs adopt IT is to enhance their competitiveness [23][34]. Therefore, SMEs may feel the pressure when they see more and more companies in the industry adopting the integration technologies to solve the technical difficulties caused by the incompatibility of systems, especially if it is their business partners, competitors or larger trading partners. Thus, SMEs will feel under pressure and the need to adapt to the IS integrated environment to remain competitive. According to various literature, like Iacovou et al's.[23], the most significant reason that pushes SMEs to adopt integration technology is to gain a competitive advantage.

Based on the discussion above, the authors found that firstly, due to SMEs' resource poverty, SMEs' motivations to turn to adopting integration technologies mostly comes from external forces. This is different from large organisations, as their motivations mostly arise from their technical, financial, strategic and managerial needs [45]. Secondly, the different integration needs between SMEs and large organisations might be caused by their different business complexity [43]. The interpretation of business complexity here means whether the condition of being a complex organisation is related to their adoption of integration technologies. After years of different technological purchases, enterprises have ended up with disparate systems spread throughout different units. However, the number of systems to be managed (i.e. disparate systems) is different between SMEs and large companies. For example, SMEs may only have a few systems, whereas large organisations may have many. Therefore, some SMEs (with only 10 employees or less) may find it ineffective to adopt integration technologies since there are not many disparate systems within the organisations. In this case, adopting integration technologies

to support SMEs' IS integration will only increase their capital or maintenance costs and add complexity to their existing operations, unless there are some irresistible reasons. For example, an SME's trading partners might require them to do so, or pressure from the government may make them act. As for larger organisations, since they are relatively complex organisations compared to SMEs (e.g. with many disparate systems within the organisation), adopting integration technologies can help them solve their integration problems, increase effectiveness, and speed up transactions, etc.

Thus, the discussion in this section demonstrates that different sized companies might have different needs and ways of managing their adoption of integration technologies. Hence, the researcher suggests that SMEs' integration needs might be different from those of large companies, and this might affect their adoption decisions. Therefore, the following research question is formed:

RQ3: *In what ways does SMEs' integration needs differ from large companies?*

II. 4 Integration Technologies Adoption by SMEs and Large Organisations

Due to SMEs' inadequate resources, limited knowledge, lack of 'know-how' about IS, and several other constraints, some researchers have found that small businesses generally face greater risks in IS implementation and the use of information technology than large businesses [12][13][23]. Thus, managers in SMEs have been characterised as having reservations about the adoption and use of information systems [6][46]. However, these reservations have not always obviated the benefits and successes such organisations can achieve from IS. In the early days, SMEs tended to use IS as tools to automate their standard administrative functions, e.g. accounting, budgeting and inventory control, etc. Until recently, there has been growing literature addressing the issue of using IS for a competitive advantage amongst SMEs [34]. According to Lin *et al.*, [30], the increasing interest in the strategic use of IS by SMEs is based on three factors: (a) the increased adoption of IS and its effective use by competitors, (b) a decrease in the cost of IS so that it is accessible to SMEs, and (c) the ability for IS to allow SMEs to mask their size from their external partners. Due to these reasons some SMEs have turned to the adoption of integration technologies as a new strategy to improve their competitiveness.

The review of the literature has shown that some SMEs adopt ERP and EDI to automate their business processes, as well as showing that there are only a few prior studies that have focused on EDI and ERP in small businesses. These studies include those by Iacovou *et al.* [23], [23], Daniel [14], Hughes *et al.*, [22], Kuan and Chau [28], Waarts *et al.*, [48], Ravarini *et al.*, [36] and Tagliavini *et al.*, [43]. Among these studies on adoption, the model proposed by Iacovou *et al.*, [23] presents the most comprehensive research that focuses on the adoption of integration technologies (EDI) in small

businesses [28]. Most of the literature on this subject that has been reviewed mainly focuses on the adoption of EDI and ERP, with studies related to EAI and Web Services adoption in SMEs proving to be largely lacking. This might be due to the fact that EAI and Web Services are only beginning to emerge and it is in the early stages of adoption [19]. Another reason might be that SMEs feel it unnecessary to adopt EAI or Web Services due to the extra costs and expertise required to implement these integrative technologies.

Opposite to studies on SMEs, EAI and Web Services adoption models and studies for larger organisations are available. Many studies have focused on different aspects of adopting EDI, EAI and Web Services in terms of supporting IS integration in large organisations. To better understand these factors reported in the literature, the authors analyse them and this is shown in Table 1. Factors like competitive pressure, Dependency on Partners/ Trading Partners Readiness/Pressure, External Pressure, Perceived Financial Cost/ Financial Resources and Perceived Governmental Pressure that particularly focus on SMEs are highlighted.

Factors derived from the literature	EAI	EDI	ERP	Web Services
Adopter Characteristics			✓	
Availability of Standards		✓		✓
Barriers	✓			
Business Complexity			✓	
Competitive Pressures	✓	✓		
Customer Power		✓		
Dependency on Partners/ Trading Partners Readiness/pressure	✓	✓		
Environmental Characteristics			✓	
Evaluation Framework for the Integration Technology and Packages	✓			
External Pressure	✓	✓		
Extent of Organisational Change			✓	
External Environment Characteristics			✓	
IS Innovation Type				✓
IT Sophistication	✓	✓		✓
IT Infrastructure	✓			✓
Internal Environment Characteristics			✓	
Internal Pressure	✓			

Innovation Characteristics/ Perceived Innovation Characteristics			✓	
Organisational Characteristics			✓	
Organisational Readiness		✓		
Perceived Financial Cost/ Resources	✓	✓		✓
Perceived Benefits (Direct and Indirect benefits)	✓	✓		✓
Perceived Technical Competence/ Technological Skills Readiness	✓	✓		✓
Perceived Industry Pressure	✓	✓		
Perceived Governmental Pressure		✓		
Prior EDI experience		✓		
Security		✓		✓
Support/ Organisational Support	✓	✓		✓
Stakeholders				✓
Supplier Trust		✓		
Supplier Commitment		✓		
Technical Factors	✓			✓
The desire for faster and better communication		✓		

Table1. Summary of Factors that Influence Organisations' Integration Technologies Adoption Decision

From Tables 1, the authors found that firstly, similar factors are sometimes used to explain different adoptions of integration technologies (i.e. common factors). For example, IT sophistication, perceived benefits, technical competence, support and financial resources (i.e. cost) factors were applied to explain EAI, EDI and Web Services adoptions in many studies. Therefore, these factors can be considered as the most important factors for explaining the adoption of integration technologies.

Secondly, the authors found that only a few factors were used to explain both the adoption of integration technologies by SMEs and large organisations. For instance, factors like perceived benefits, perceived financial costs and external pressures were used to explain the adoption of integration technologies by SMEs as well as large organisations. However, among these research papers, there was only one of the papers in which the authors referred to this research concerning the EAI and Web Services adoption in SMEs. This indicates that (a) there is a lack of literature on EAI and Web Services adoption in SMEs; and (b) most of the factors identified from the normative literature can not be equally applied to both SMEs and large companies to interpret their

decision whether to adopt integration technologies because having one piece of evidence is not enough to represent every example.

Thirdly, similar factors were highlighted in many research papers to explain the adoption of integration technologies by SMEs. For example, *competitive pressures*, *dependency on partners*, *external pressure*, *perceived financial cost*, *prior EDI experience* and *perceived governmental pressure* were used in many studies to explain the adoption of integration technologies by SMEs. This indicates that the aforementioned factors here are the main/important factors for the adoption of integration technologies by SMEs. However, these factors can also be used to explain the adoption decision by large organisation, even though it may not necessarily be a good one. For example, the perceived governmental pressure might not be a factor that assists the studying of adoption decisions in large organisations, as this factor is particularly used to explain the adoption decision by SMEs. The reason for this is that large organisations like SMEs often find it hard to adopt integration technologies without any kind of support (e.g. not only support from vendors and consultants but also from the government and their suppliers, etc) due to their natural resource constraints. Moreover, as mentioned in the literature review, SMEs might be forced to adopt integration technologies as their business partners or governments require them to do so [8]. This situation might not be appropriate for their larger counterparts as they are usually the stronger partners in inter-organisational relationships, when compared to the SMEs [40][42]. Another explanation is that most of the research papers that focused on the adoption of integration technologies in large companies did not include *perceived governmental pressure* as a factor that might explain or influence their adoption decision.

In accordance with the above considerations, the researcher proposes that there is a high possibility that SMEs and large companies take their decision for the adoption of integration technologies by mostly focusing on different factors (as shown in Tables 3.1, 3.2 and 3.3). This will be illustrated in more detail in Sections 3.3 and 3.4. This assumption matches with the literature, where it is reported that the adoption of integration technologies is different for both large and small companies [23][28]. Thus, the following research question is raised for further investigation:

RQ4: Do SMEs and large companies consider different factors when taking decisions for the adoption of integration technologies?

II. 5 Time

In addition, according to the literature, the authors found that most of the factors that focused on the adoption of integration technologies by SMEs are mostly external forces e.g. governmental support, external pressures, pressure from trading partners, etc. This indicates that in many situations SMEs are forced to adopt integration technologies as their

partners require them to do so [23][28]. Thus, to remain competitive, SMEs have no choice but to adopt integration technologies. Due to these reasons, when referring to the adoption life cycles, some literature suggest that SMEs tend to be the late adopters (late majority/laggards) in the adoption of new technology/innovation, rather than the early adopters [23] [28] [31].

Laggards can be summarised as those who only adopt a technology when they have no choice. In fact, many laggards do not explicitly adopt technologies at all but rather acquire them accidentally when a particular technology is a component of a packaged solution [39]. Laggards' innovation-decision process is relatively lengthy, with adoption and use lagging far behind the awareness-knowledge of a new idea. Resistance to new technologies on the part of laggards may be entirely rational from the laggards' viewpoint, as their resources are limited and they must be certain that a new idea will not fail before they adopt it. Kirby [27] and Storey [42] are among those others who claim that SMEs can not afford to fail due to their limited resources. Therefore, most SMEs can be categorised as laggards.

The adopters in the late majority group not only want to be certain that the new technology works, they also want to wait until it's been widely adopted and standardised. They do not consider that the technology offers them any competitive advantage, even though they recognise that they can not live without it once their partners or competitors have adopted it. The pressure of peers is necessary to motivate adoption. In accordance with this point, as mentioned before, sometimes SMEs are forced to adopt integration technologies as their partners require them to do so (e.g. external pressure). Thus, SMEs can also be categorised in the late majority group.

However, there might be an exceptional case where SMEs might be considered as innovators, such as when SMEs are Hi-technology firms. Hi-technology SMEs might use more advanced or sophisticated information technologies for their production or information systems management than those SMEs from other sectors.

Nevertheless, most large companies tend to be in the early adopters/early majority group, with even some of them being classified as innovators. Early adopters are more interested in the business and competitive advantages of a new technology rather the technology itself, but they are still risk-takers since they are willing to adopt a new technology before it has been proven or widely accepted. Those in the early majority group are the pragmatists [39]. They do not want to take the risk of adopting a technology too early, even though they also recognise that waiting too long can put them at a substantial disadvantage. They want to make sure the technology works for others before they invest [26].

Thus, based on the above discussion, it suggests that time plays an important role in terms of integration technologies adoption, as late adopters may find that they have a competitive disadvantage [26]. Kaye [26] suggested that by extending the middle of the early-adopter phase into

the start of the late-majority phase, this period may offer a competitive advantage to the adoption of integration technologies. However, at some time early in the late majority phase, having implemented integration technologies ceases to offer any competitive advantage, and not having implemented anything begins to be a problem. To this end, the following research question is raised:

RQ5: *Can early adoption of integration technologies by the organisations gain competitive advantages?*

III. Conceptual Framework

Based on the discussion and identified research questions in Sections 2.1, 2.2, 2.3, 2.4, and 2.5, the authors identified the potential parameters that can be used to explain the adoption of integration technologies by SMEs and large companies. These adoption parameters are *company size*, *time*, *nature*, *integration needs*, *adoption factors for large companies* and *adoption factors for SMEs*, which are then illustrated in a cube diagram in Figure 1, which shows the dimensions for the integration technologies adoption between SMEs and large organisations.

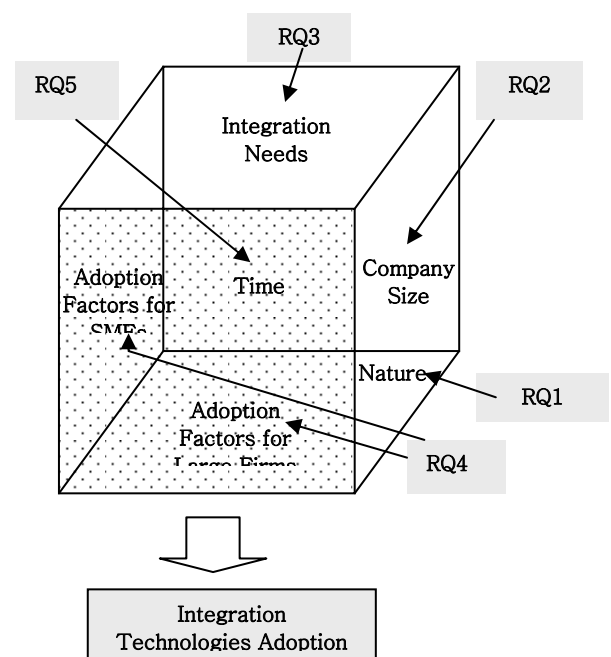


Figure1. Dimensions for Adoption of Integration Technologies between SMEs and Large Organisations

IV. Methodology

The questionnaire contained two sections regarding: (1) general company information, and (2) integration technologies adoption. The questions in this section were categorised into 5 parts according to the parameters identified in Chapter 3, Figure 3.2: *nature*, *integration needs*, *company size*, *adoption factors* and *time*. The questionnaire was validated by two MIS managers from an IT

manufacturing company in Taiwan. They were asked to identify questions, and any for which answers may not be easily available. The questionnaire was then mailed to computer professionals of 500 firms of any size and industry in Taiwan. Enterprises were categorised as SMEs in Taiwan if their paid-in capital was less than NT\$60 million (US\$1.8 million), or the number of regular employees did not exceed 200. The firms were chosen randomly from the database provided by the Industrial Bureau of Ministry of Economics (MOE) in Taiwan. The respondents were asked: (1) to complete if they are using integration technologies, (2) to complete it if they had evaluated integration technologies in the past and had chosen not to use them, and (3) to ignore the questionnaire if the firm does not belong to either category, but to explain their reasons.

A total of 101 responses were received and 68 of them were useable. 40 (58%) responses were from large organisations and 28 (42%) were from SMEs. 59 (87%) of the responding firms were integration technology users (this includes ERP, EAI, EDI and Web Services), and 53 of these were IT manufacturing/high-technology firms. The remaining 9 of the responding firms were non-users, and 4 of these were IT manufacturing/high-technology firms. The responding firms represented diverse industries, such as manufacturing, IT industry, high-technology industry, services sectors and merchandising. The survey results were then analysed by descriptive statistical method and are analysed in the following sections.

V. Survey Results Analysis

V.1 Nature of Organisations

Integration technologies implementation requires capital investment and may involve other expenditure in upgrading the computer and integrating some systems. It seems that large firms should be able to afford such investments more easily than smaller ones, and therefore integration technologies users' firms are expected to be the larger ones. According to the data, among the 9 non-users, 8 are SMEs, (see Table2). The reasons for not adopting integration technologies are shown in Table 3. In addition to those reasons, further reasons for not adopting integration technologies were found to be: (1) that most SMEs do not fully understand what integration technologies (EDI, ERP, EAI and Web Services) are, and (2) that some SMEs find it unnecessary to adopt integration technologies as they are satisfied with the current technologies they are using (e.g. the Internet is good enough for their daily operations). In this research, the author is particularly interested in the integration technologies adopters (in total, 59 adopters).

Moreover, Table 4 shows that EAI has not been popular among SMEs compared to other integration technologies. The possible explanation for this is that the high investment cost and complexity associated with EAI might cause concern to many organisations, especially SMEs. According to Charlesworth and Jones [7], integration technologies need to be "dumbed-down" to effectively communicate the

benefits and issues at the most appropriate level within the organisation.

	Responses	User Firms	Nonuser Firms
SMEs	28	(20) 71.4%	(8) 28.6%
Large	40	(39) 97.5%	(1) 2.5%
Total	68	(59) 86.7%	(9)13.2%

Table 2. User and Nonuser Percentage

Reasons	Responses
Costs	33.3%
Security	11.1%
Uncertainty	11.1%
Financial resources	11.1%
Skills	11.1%
Others	22.3%

Table3. SMEs' Reasons for not Adopting Integration Technologies

	EAI	EDI	ERP	Web Services
SMEs	0	35%	50%	15%
Large	5.1%	51.3%	90%	38.5%

Table4. Integration Technologies Adoption Percentage

Therefore, based on the survey results, the researcher suggests that the nature of SMEs might be an obstacle to their adoption of integration technologies. The reasons for this are: (1) the results indicate that cost is still an obstacle to SMEs, as they cannot really afford to spend extra money on R&D investment; (2) some SMEs still find it unnecessary to implement integration technologies, as there are not that many employees within the organisation; and (3) most SMEs still lack knowledge regarding integration technologies compared to large counterparts.

V.2 Company Size

The survey results reported in Table 5 suggest that SMEs and large organisations manage their IS in different ways. The majority of the integration technologies users in large organisations (71.4%) reported that the MIS department is in charge of the companies' information systems. As for SMEs, there were only around 40% that reported this. The remaining 60% indicated that their IS are often managed under managers or are outsourced. The possible explanations are that, firstly, the culture of a small enterprise is tied in with the needs, desires and abilities of its owner [3]. The owners of SMEs often like controlling their own destiny and doing things differently. Thus, the managers like to manage the IS on their own. Secondly, according to Carter and Evan [5], due to the lack of financial resources and expertise in IT, SMEs usually do not develop IS on their own. Instead, they rely more on standardised and *off-the-shelf* software packages, and normally seek external support for their IT problems, such as friends, vendors or consultants. Thus, many SMEs like to outsource their systems. This shows that companies of different sizes manage their IS and integration technologies differently.

	MIS Dept	Managers	Outsourcing	Others
SMEs	40%	33.3%	20%	6.7%
Large	71.4%	14.3%	9.5%	4.8%

Table 5. Information System Management in Organisations

V.3 Integration Needs

Table 6 shows that the reasons that push SMEs and large firms to turn to integration technologies are different. The majority of large organisations reported that integration technologies can provide real-time data which can help them to eliminate: (1) systems heterogeneity, (2) data redundancy, and (3) low data quality. For example, multiple applications store data for the same entity (e.g. orders), but there is often an inability to combine data and take decisions, since there is: (1) data incompatibility, (2) confusion regarding data latency, or (3) communication problems. As for SMEs, the majority reported that external pressure and competition are the main reasons that push them to adopt integration technologies. There are only 2.6% and 7.7% of large organisations which reported this. Thus, it clearly shows that integration needs are different between SMEs and large organisations, and this can influence the ways they approach integration technologies.

Additionally, Table 4 shows that the newer the technologies, the less likelihood that SMEs will adopt them. For instance, the adoption rate for EAI and Web Services among SMEs is relatively low compared to their large counterparts. This suggests that the more complex and expensive the integration technologies are, the less likelihood that SMEs will adopt them. For large organisations, they will use the integration technologies in a circumstance it will help them to increase their competitiveness or solve a particular problem. This also shows the different motivations towards integration technologies adoption between SMEs and large organisations.

Integration Needs	SMEs	Large Firms
External pressure	45%	2.6%
Competition	40%	7.7%
Technical reasons	10%	2.6%
Financial reasons	10%	5.1%
Provide solution to the existing problem	20%	12.8%
Managerial reasons	35%	43.6%
Strategic reasons	20%	7.7%
ERP can not fully automate and integrate business process	10%	2.6%
Others	0	2.6%

Table 6. Integration Needs Related Factors

V.4 Time

Table 7 demonstrates that the timing of integration technologies adoption is different between SMEs and large organisations. For instance, the majority of large

organisations reported that they have adopted integration technologies for more than 10 years. As for SMEs, this only applies to around 15% of them. The majority of SMEs lie between 5 to 10 years. This indicates that SMEs tend to be later adopters compared to large organisations.

	Test Value = 0					
	T	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
SMEs	6.848	67	.000	.412	.29	.53
Adopted	16.836	67	.000	.809	.71	.90
Competitive advantages	1.000	2	.423	.333	-1.10	1.77
Don't know	2.000	2	.184	.667	-.77	2.10

Table 7. Timing and Competitive Advantages

Table 8 shows that the early adoption of integration technologies can help organisations to gain some minor competitive advantages. However, many of the respondents claimed that it is hard to tell whether adopting integration technologies gives them a major competitive advantage or not. Nevertheless, they were sure that not having implemented any of these integration technologies may become a problem for their companies.

	< 10 Years	5-10 Years	> 5 Years	Very Recently	- Planning
SMEs	15%	35%	25%	15%	10%
Large	35.9%	23.1%	10.3%	5.1%	2.6%

Table 8. Timing for Integration Technologies Adoption

V.5 Adoption Factors for SMEs and Large Organisation

Table 9 shows that SMEs and large organisations face different problems when integrating their IS. The majority of SMEs reported that due to their lack of technical skills they have encountered many technical problems. As for large firms, they reported that they have encountered many strategic problems when integrating their information systems (around 33.3%).

Problems Faced When Adopting Technologies	SMEs	Large Firms
Financial problems due to the limited resources	35%	10.3%
Technical problems due to the lack of expertise's support and technical skills	60%	12.8%
Organisational change	20%	17.9%
Managerial problems	25%	25.6%
Strategic problems	15%	33.3%

No problem at all	0	10.3%
Others	5%	2.6%

Table 9. Problems Faced When Adopting Integration Technologies

Adoption Factors	SMEs	Large Firms
Availability of standards	70%	56.4%
Barriers	20%	7.7%
Perceived industry pressure	15%	2.6%
Business complexity	5%	7.7%
Customer power	35%	5.1%
Internal pressure	10%	2.6%
IT infrastructure	20%	12.8%
Technology characteristics	15%	5.1%
Organisational readiness	20%	10.2%
Extent of organisational change	30%	12.8%
IT infrastructure	10%	12.8%
Security Technical factors	5%	10.3%
Competitive pressures	20%	12.8%
Dependency on partners	25%	7.7%
External pressure	5%	5.1%
IT sophistication	25%	7.7%
Support	20%	17.9%
Perceived financial cost	20%	12.8%
Perceived benefits	40%	35.9%
Perceived technical competence	30%	5.1%
Perceived government pressure	15%	2.6%
Others	0	2.6%

Table 10. Integration Technologies Adoption Factors

Table 10 indicates that SMEs and large organisations take decisions for the adoption of integration technologies, mostly focusing on the different factors. For example, around 35% of SME respondents reported that customer power influences their adoption decisions, but only 5.1% of large organisations reported this. Another example is that 25% of SMEs claimed that dependency on partners is a factor that influences their adoption decisions, but only 7.7% of large organisations reported this.

VI. Conclusion

This research has attempted to study the factors affecting the integration technologies adoption in SMEs based on comparative analysis between SMEs and large companies. In doing so, the authors critically analyse the normative literature regarding the integration technologies adoption in both SMEs and large organisations with number of research questions raised. These research questions are: (1) In what ways does SMEs' integration needs differ from large companies, (2) Is the nature of SMEs a real obstacle to the adoption of integration technologies, (3) What is the relationship between integration technologies and their adoption in companies of different sizes, (4) can early adoption of integration technologies by organisations gain

competitive advantages, (5) Do SMEs and large companies consider different factors when taking decisions for adoption of integration technologies, and (6) if the adoption factors for SMEs and large organisations are thought to be different, to what extent do: (1) integration needs, (2) nature of organisations, (3) company size, and (4) time, influence the different adoption factors.

Based on these research questions and the analysis of the literature, the authors found that the differences between SMEs and large companies on their *nature of organisations*, *integration need*, *company size*, *adoption factors* and *their timing of adoption* are important parameters affecting integration technologies adoption.

The data for the current study were collected using a postal questionnaire, which limited the ability to include important variables or information regarding the adoption of integration technologies. Therefore, it would be useful to collect in-depth data by conducting interviews that examine more information regarding the differences between SMEs and large organisations in relation to their integration technologies adoption. This will provide a clearer and more complete picture of different integration technologies adoption between SMEs and large organisations.

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Credibility Theory: A New Branch of Mathematics that Studies the Behavior of Fuzzy Phenomena

Baoding Liu

Uncertainty Theory Laboratory, Department of Mathematical Sciences

Tsinghua University, Beijing 100084, China

liu@tsinghua.edu.cn

<http://orsc.edu.cn/~liu>

Abstract: Fuzzy set was initialized by Zadeh via membership function in 1965, and was well developed and applied in a wide variety of real problems. In order to measure a fuzzy event, Zadeh proposed the concept of possibility measure in 1978. Although possibility measure has been widely used, it has no self-duality property. However, a self-dual measure is absolutely needed in both theory and practice. In order to define a self-dual measure, Liu and Liu presented the concept of credibility measure in 2002. Credibility theory is a branch of mathematics that studies the behavior of fuzzy phenomena. An axiomatic foundation of credibility theory was given by Liu in 2004. In fact, the whole credibility theory was derived from the following five axioms:

Axiom 1. $\text{Cr}\{\Theta\} = 1$.

Axiom 2. $\text{Cr}\{A\} \leq \text{Cr}\{B\}$ whenever $A \subset B$.

Axiom 3. Cr is self-dual, i.e., $\text{Cr}\{A\} + \text{Cr}\{A^c\} = 1$ for any $A \in \mathcal{P}(\Theta)$.

Axiom 4. $\text{Cr}\{\cup_i A_i\} \wedge 0.5 = \sup_i \text{Cr}\{A_i\}$ for any $\{A_i\}$ with $\text{Cr}\{A_i\} \leq 0.5$.

Axiom 5. Let Θ_k be nonempty sets on which Cr_k satisfy the first four axioms, $k = 1, 2, \dots, n$, respectively, and $\Theta = \Theta_1 \times \Theta_2 \times \dots \times \Theta_n$. Then

$$\text{Cr}\{A\} = \begin{cases} \sup_{(\theta_1, \theta_2, \dots, \theta_n) \in A} \min_{1 \leq k \leq n} \text{Cr}_k\{\theta_k\}, & \text{if } \sup_{(\theta_1, \theta_2, \dots, \theta_n) \in A} \min_{1 \leq k \leq n} \text{Cr}_k\{\theta_k\} < 0.5 \\ 1 - \sup_{(\theta_1, \theta_2, \dots, \theta_n) \in A^c} \min_{1 \leq k \leq n} \text{Cr}_k\{\theta_k\}, & \text{if } \sup_{(\theta_1, \theta_2, \dots, \theta_n) \in A} \min_{1 \leq k \leq n} \text{Cr}_k\{\theta_k\} \geq 0.5 \end{cases}$$

for each $A \in \mathcal{P}(\Theta)$. In that case we write $\text{Cr} = \text{Cr}_1 \wedge \text{Cr}_2 \wedge \dots \wedge \text{Cr}_n$.

Let Θ be a nonempty set, $\mathcal{P}(\Theta)$ the power set of Θ . The set function Cr is called a credibility measure if it

satisfies the first four axioms. The triplet $(\Theta, \mathcal{P}(\Theta), \text{Cr})$ is called a credibility space.

A fuzzy variable is defined as a function from a credibility space $(\Theta, \mathcal{P}(\Theta), \text{Cr})$ to the set of real numbers. Then its membership function is derived from the credibility measure by

$$\mu(x) = (2\text{Cr}\{\xi = x\}) \wedge 1, \quad x \in \mathfrak{R}.$$

Conversely, let ξ be a fuzzy variable with membership function μ . Then for any set B of real numbers, we have

$$\text{Cr}\{\xi \in B\} = \frac{1}{2} \left(\sup_{x \in B} \mu(x) + 1 - \sup_{x \in B^c} \mu(x) \right).$$

The expected value of ξ is defined by

$$E[\xi] = \int_0^{+\infty} \text{Cr}\{\xi \geq r\} dr - \int_{-\infty}^0 \text{Cr}\{\xi \leq r\} dr$$

provided that at least one of the two integrals is finite.

This talk will introduce the concepts of credibility measure, credibility distribution, expected value, variance, entropy, characteristic function, convergence almost surely, convergence in credibility, convergence in mean, convergence in distribution, and show the credibility subadditivity theorem, credibility extension theorem, credibility semicontinuity law, sufficient and necessary condition for credibility distribution, linearity of expected value operator, inversion formula. The interested reader may download the book from <http://orsc.edu.cn/~liu>.

Keywords: fuzzy variable, credibility measure, axioms.

Baoding Liu has been a full Professor at Tsinghua University since 1998. He graduated from the Nankai University in 1986, and received the M.S. and Ph.D. degrees from Chinese Academy of Sciences in 1989 and 1993, respectively. His current research interests include uncertainty theory, uncertain programming, intelligent algorithm and applications. He is the author of 7 books, including *Uncertainty Theory* (Springer), *Theory*

and Practice of Uncertain Programming (Physica), *Decision Criteria and Optimal Inventory Processes* (Kluwer), and *Uncertain Programming* (Wiley). Dr. Liu serves on the editorial boards of 6 international journals, including IEEE Transactions on Fuzzy Systems, Information: An

International Journal, Fuzzy Optimization and Decision Making, Asian Information-Science-Life, International Journal of Internet and Enterprise Management, and International Journal of Operations Research.

Multi-Plant Assembly Planning Model in Collaborative Manufacturing and Commerce Systems

Yuan-Jye Tseng, Jia-Fong Jhang, Feng-Yi Huang
Department of Industrial Engineering and Management, Yuan Ze University
135 Yuan-Tung Road, Chung-Li, Taoyuan 320, Taiwan
E-MAIL: ieyjt@saturn.yzu.edu.tw

Abstract: With emerging e-business models in a global supply chain, the components or parts of a product may be distributed and produced at various plants in a collaborative way for the purpose of expanding capacity and reducing costs. For an assembled product, the assembly operations for assembling the product may be performed at different assembly plants at various geographical locations. In the collaborative commerce environment, it is required to develop a multi-plant assembly planning model for organizing and distributing the assembly operations to the suitable plants for completing the final product. In this research, a multi-plant assembly planning model for generating and evaluating the multi-plant assembly sequences is presented. A graph-based model is developed to model and generate the assembly sequences. The feasible assembly sequences are analyzed and evaluated based on several cost objectives. The multi-plant assembly planning model is formulated with an aim of minimizing the total of assembly costs and multi-plant costs. As a result, the optimized multi-plant assembly sequences can be obtained and each of the assembly operations is assigned to the suitable plant with a minimized cost. Example parts are tested and discussed.

Keywords: Collaborative commerce; SCM; Collaborative manufacturing; Assembly planning; Multi-plant.

I. Introduction

The main purpose of assembly planning is to organize a proper assembly sequence with which the components can be grouped or fixed together to construct a final product. A component is a basic part where no assembly operation occurs. A subassembly is a group of assembled components built for certain functional or manufacturing purposes, but a subassembly is not a final product. An assembly is a final product in which all the components are assembled. An assembly sequence is an ordered assembly operations for grouping and fixing the components and subassemblies to create the final product.

In the related research for assembly planning, it can be summarized that assembly planning can be performed in three stages: (1) assembly modeling and representation, (2) assembly sequence generation, and (3) assembly analysis and evaluation. A recent review can be found in Abdullah *et al.* (2003) in which the research into software and other tools

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to support the closely related methodologies of assembly system selection, design for assembly, and assembly planning is reviewed. The previous research in assembly planning can be classified into three categories based on different approaches and purposes. The first category uses rules or knowledge bases to perform generation of different assembly sequences such as developed in Baldwin *et al.* [1], Tonshoff [12], Ye and Urzi [14], and Swaminathan and Barber [11]. The second category presents automatic generation of feasible assembly sequences using graph representation forms. Various graph-based representation schemes are presented in Homem de Mello and Sanderson [7], Santochi and Dini [10], and Lin and Chang [9], and Choi *et al.* [5]. The third category focuses on assembly analysis and evaluation for searching the better or the optimal assembly sequence. The research in this class includes Homem de Mello and Sanderson [7], Ben-Arieh and Kramer [3], Laperriere and ElMaraghy [8], , Gottipolu and Ghosh [6], Zha *et al.* [15], Zhao and Masood [16], Tseng and Liou [13], and Chen *et al.* [4].

In a typical assembly planning scheme, the assembly sequences for producing a product are designed and arranged to be performed in a single plant. The available assembly operations and assembly workstations are restricted in a single plant. Also, the assembly costs associated with the assembly operations are constrained in a specific plant location.

In a multi-plant collaborative commerce model, a product can be designed and manufactured at different plants at multiple locations. Due to the increasing product complexity and increasing production scale, a multi-plant manufacturing scheme is usually adopted to reduce production costs, enhance product variety, and to expand production capacity. For an assembly product, the multi-plant system may be composed of several manufacturing plants and multiple assembly plants located at different geographical locations. It is important to find the best place to manufacture each component, the best place to assemble the components and subassemblies, and the best place to assemble the final product. Therefore, it is required to develop a multi-plant assembly planning model to integrate the cross-plant resources and costs.

In this research, a multi-plant assembly planning model is presented. In this multi-plant model, the components and subassemblies are distributed and assembled at different

plants. In a multi-plant assembly sequence, each plant is assigned and arranged to perform a portion of the assembly operations to complete the product. At the final step, the components and subassemblies are gathered and assembled to build the final product at the final plant.

A graph-based model is developed to formulate the multi-plant assembly sequences. The assembly sequences are analyzed and evaluated based on assembly operation costs and multi-plant costs. The following model Assembly Sequence Tree (AST) describing the relationship between components and subassemblies of a product is introduced. The graph-based tree representation model is developed to generate and represent the feasible assembly sequences. With the feasible assembly sequences as input, a linear programming model is formulated to evaluate all the feasible assembly sequences. The objective attempts to find the optimized multi-plant assembly sequences with the lowest cost. As a result, the multi-plant assembly sequences can be evaluated and the assembly operations are assigned to the most suitable plants.

II. Graph-Based Model for Eprese-Nting Assembly Sequences

In this research, a graph-based model is developed for representing the components and the assembly operations. The graph-based model is used as input for generating the feasible sequences. The feasible sequences are then evaluated in the next section.

A graph-based tree called Assembly Sequence Tree (AST) is developed to represent the feasible assembly sequences. A directed graph $G = (E, P)$ is used to represent an AST where E is the set of component nodes and P denotes the set of linking arcs between nodes. A linking arc from node i to node j is represented by an operation arc in P and is denoted as pk . An operation arc represents the assembly operation required to assemble the two component nodes. The precedence is represented by the directed linking arc from node i to node j . Each graph contains a single source node and a destination node and the graph is called a feasible assembly sequence. A feasible sequence can be generated by traversing the component nodes through the operation arcs.

Using the subassembly information of a product as input, a feasible assembly sequence can be generated and represented as an AST. A search can be performed starting from the base component node to traverse all the component nodes until all the nodes are visited and all the assembly operations are executed. By traversing the nodes and arcs in a systematic way, all the feasible assembly sequences can be generated. As an illustrative example, the component and subassembly information of an example product is shown in Figure 1, the generated AST is shown in Figure 2.

III. Formulation of Multi-Plant Assembly Planning Model

Since the feasible assembly sequences may be combinatorial, the focus of the research is on developing a new model for finding the optimized multi-plant assembly sequence with a minimized cost. To formulate the problem under investigation, the following notations are used.

- E_G : set of subassemblies,
- F : set of manufacturing plants,
- Y : set of assembly plants,
- E : set of components,
- B : set of feasible assembly sequences,
- X : set of assembly operations,
- $As_{[E_R]bx}$: assembly operation time,
- $Num_{[E_R]efy}$: number of components needs to be transported from a manufacturing plant to an assembly plant,
- C : manufacturing cost for components,
- $Co_{[E_R]y}$: assembly operation cost for a subassembly group,
- $Cr_{[E_R]dfy}$: transportation cost for component from a manufacturing plant to an assembly plant,
- $Ct_{[E_R]y}$: transportation cost for transportation to the next assembly operation,
- Cp_y : assembly operation cost at an assembly plant,
- $Q_{[E_R]b}$: decision variable of feasible assembly sequence in E_g and $Q_{[E_R]b} \in (0,1)$,
- $E_{[E_R]efy}$: decision variable representing component e of E_g transported from f to y in E_g ,
- $H_{[E_R]y}$: decision variable representing E_g assembled at the assembly plant y .

The problem formulation is as follows.

1. Assembly costs:

$$Co_{[E_R]y} = \min \sum_{b=1}^B \sum_{x=1}^X (As_{[E_R]bx} \times Cp_y) \times Q_{[E_R]b} \quad s.t. \sum_{b=1}^B Q_{[E_R]b} = 1 \quad (1)$$

The objective function attempts to minimize the total cost of assembly operations.

2. Multi-plant assembly costs:

$$\min \sum_{E_R=1}^{E_G} \sum_{y=1}^Y Co_{[E_R]y} \times H_{[E_R]y} +$$

$$\begin{aligned}
& \sum_{E_R=1}^{E_G} \sum_{e=1}^E \sum_{f=1}^F \sum_{y=1}^Y C_{r_{[E_R]efy}} \times Num_{[E_R]efy} \times E_{[E_R]efy} + \\
& \sum_{E_g=1}^{E_G} \sum_{y=1}^Y C_{t_{[E_g]y}} \times H_{[E_g]y} \\
& s.t. \sum_{f=1}^F \sum_{y=1}^Y E_{[E_R]efy} = 1 \\
& \sum_{y=1}^Y H_{[E_g]y} = 1
\end{aligned} \tag{2}$$

The cost objective is the total of the total assembly operation cost, the transportation cost from a manufacturing plant to an assembly plant, and the transportation cost for delivering a subassembly from one assembly plant to the next assembly plant. The constrain ensures that each component in a subassembly can be transported only one time from one plant to the next plan and each subassembly is assigned only one time to the plant with the lowest cost. With the above formulation, the optimized output of the model including the assembly sequence, the assembly time, the assembly cost, and the assembly plant location can be obtained.

IV. Test Result and Discussion

In this section, a wireless mobile phone is used as an example product to show the models and the tested results. The optimized solution of the linear programming problem is obtained using the Lingo software.

The part definitions and the product information are given as input. A description of the components of the product is shown in Table 1. It is assumed that for the purpose of reducing cost and expanding capacity, the seven manufacturing plants and three assembly plants need to be considered. There are fifteen components in the product given as {1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15}. There are seven manufacturing plants {F1, F2, F3, F4, F5, F6, F7} as shown in Table 1. There are three assembly plants {Y1, Y2, Y3} as shown in Table 2. Figure 2 illustrates the component and subassembly structure of the product. The AST list is shown in Figure 3. The three assembly plants and the assembly operation cost for each assembly plant is listed in Table 2. The transportation cost for transporting a component from a manufacturing plant to an assembly plant is shown in Table 3. The transportation cost for transporting a component from an assembly plant to the next assembly plant is shown in Table 4. The subassembly information is described in Table 5. With the formulation, the feasible sequences are evaluated based on cost objectives.

The optimized result of the multi-plant assembly sequence with the lowest cost is shown in Table 6. It shows that the E1 subassembly is assembled at plant Y1 and the assembly sequence is from component 1, 2, to 3. The E2

subassembly is assembled at plant Y3 and the assembly sequence is from component 4 to 5. The E3 subassembly is assembled at plant Y2 and the assembly sequence is from component 8, 7, to 6. The E5 subassembly is assembled at plant Y1 and the assembly sequence is from subassembly E1, E2, and E3, to component 9, 10, 11, and then to subassembly E4, and finally to component 14 and 15. This sequence shown in Table 7 represents the optimized multi-plant assembly sequence with the lowest cost.

Based on the formulation, the sum of two main cost factors, assembly operation cost and multi-plant transportation cost, is minimized. It is observed that, in a multi-plant environment, if the assembly operation cost of a plant is too high, then the assembly operation will not be assigned to the plant. Also, if the assembly operation cost of a plant is low enough to cover the transportation cost, then the assembly operation can be assigned to that plant. This is a practical situation in the collaborative manufacturing environment in the current global supply chain in which the manufacturing and assembly operations are distributed with justified transportation costs to the plants with low operation costs.

Since this modeling and solution method is performed with a combinatorial programming approach, a larger size of problem might lead to a complex calculation process. At this stage of the research, a model with a systematic method is provided, but the complexity problem is not further explored.

V. Conclusion

With the developing collaborative commerce and e-business models in a global logistic supply chain, a product can be designed and manufactured at different plants at multiple locations. In a multi-plant assembly sequence, the assembly operations can be performed at various assembly plants at various geographical locations. In this paper, the problem of multi-plant assembly planning is identified. A graph-based representation model is developed for representing the multi-plant assembly sequences. A mathematical programming model is formulated to evaluate all the feasible multi-plant assembly sequences. The formulated model is aimed at minimizing the total cost of assembly cost and multi-plant cost. The results present an optimized multi-plant assembly sequence in which all the components, subassemblies, and product are manufactured and assembled at the most suitable plants with the lowest cost. It can be concluded that the proposed multi-plant assembly planning model is an effective approach to solve the multi-plant assembly planning problem. Further research should be concerned with the additional cost functions such as activities generated due to the different plants located at different countries and other cost issues.

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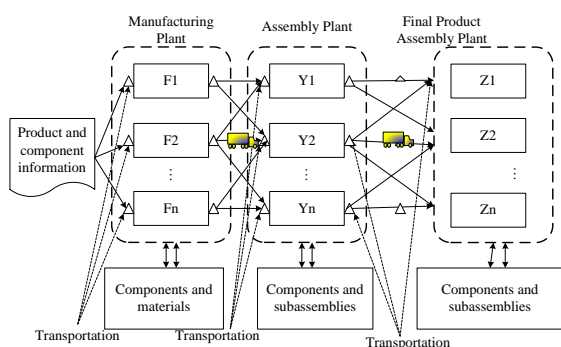


Figure 1. Illustration of a multi-plant manufacturing and multi-plant assembly scheme.

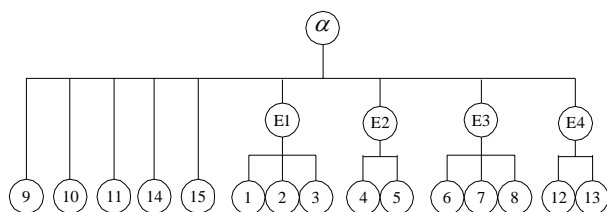


Figure 2. The components and subassemblies of the example product.

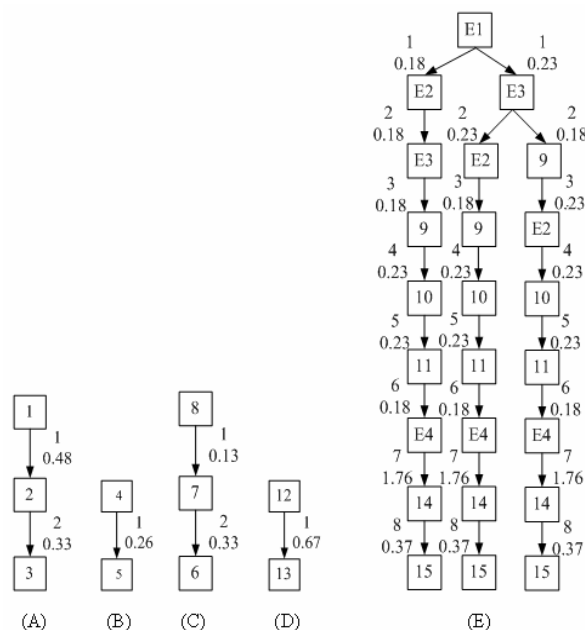


Figure 3. The AST of the example product

Table 1. The components of the example product.

Component	Description	Manufacturing plant
1	Upper case	F1
2	Keypad	F2
3	Frame	F1
4	Earphone rubber	F3
5	Earphone	F4
6	Panel upper case	F5
7	Display panel	F6
8	Backlight module	F6
9	Keypad conductor	F5
10	Printed circuit board	F7
11	I/O Connector	F4
12	Shielding	F5
13	SIM card cover	F5
14	Screw	negligible
15	Back case	F1

Table 2. The assembly operation cost.

Assembly plant	Y1	Y2	Y3
Assembly operation cost	1.8	2	0.25

Table 3. The transportation cost for transporting a component from a manufacturing plant to an assembly plant.

Component \ Assembly plant	Y1	Y2	Y3
1	15	20	50
2	20	10	55
3	20	40	60
4	30	40	8
5	60	45	15
6	40	20	5
7	60	25	80
8	30	10	60
9	40	15	10
10	60	40	30
11	60	45	15
12	50	30	10
13	30	15	6
15	15	25	50

Table 4. The transportation cost for transporting a component from an assembly plant to the next assembly plant.

Assembly plant \ Assembly plant	Y1	Y2	Y3
Y1		100	150
Y2	100		80
Y3	150	80	

Table 5. The subassembly information.

Subassembly	Components in the subassembly
E1	1, 2, 3
E2	4, 5
E3	6, 7, 8
E4	12, 13
E5	E1, E2, E3, E4, 9, 10, 11, 14, 15

Table 6. The optimized multi-plant assembly sequence with the lowest cost

Subassembly	Assembly plant	Assembly sequence	Cost
E1	Y1	1 → 2 → 3	56.258
E2	Y3	4 → 5	23.065
E3	Y2	8 → 7 → 6	55.62
E4	Y3	12 → 13	16.168
E5	Y1	E1 → E2 → E3 → 9 → 10 → 11 → E4 → 14 → 15	548.358
Cost=699.649			

An Overview of Reverse Logistics Management in the Australian Manufacturing Industries

Dushantha Dissanayake Mohini Singh
School of Business Information Technology

RMIT University

P O Box 2476V Melbourne Victoria Australia

dushantha.dissanayake@rmit.edu.au / mohini.singh@rmit.edu.au

Tel: 0061 (0)3 99251672, Tel: 0061 (0)3 99251355

Fax: 0061 (0)3 9925 5595, Fax: 0061 (0)3 9925 5850

Abstract: This paper is a discussion of reverse logistics management literature, a conceptual model showing the recovery processes and their relationships, preliminary research data, analysis and implications for the manufacturing organisations. A discussion of the findings and their implications highlighting the important role of information technologies for efficient data collection and processing of recovery operations lead to capturing value from effective management of reverse logistics.

I. Introduction

Reverse logistics is planning, implementing and controlling the efficient and cost effective flow of raw materials, in-process inventory, finished goods and related information from the end user to any previous point closer to origin, which may be in or out of the original supply chain. Similarly reverse logistics can be considered as an essential feature of strategic marketing and effective customer relationship management, as well as environmental protection and sustainable development of manufacturing organizations. It entails processing returned merchandise due to damage, seasonal inventory, restock, salvage, recalls, and excess inventory. Further reverse logistics management also includes recycling programs, hazardous material management programs, obsolete equipment disposition, and asset recovery. Although there are numerous reasons for goods to be returned, Dekker and Brito (2002) have categorised returns into few groups such as manufacturing returns, commercial returns, product recalls, warranty returns, service returns, end-of-use returns and end-of-life returns. On the other hand Roy (2003) described numbers of opportunities of reverse logistics such as economical gains by recapturing some of the costs of raw materials, used components, used products and rejects and reuse of discarded products from commercial returns and excess inventory of products and materials (Bayles 2001). Similarly Kokkinaki, Dekker, Lee and Pappis (2001) identified number of direct and indirect benefits of reverse logistics such as regaining value, achieving a competitive advantage and a positive impact on the environment.

So it is important to perform reverse logistics efficiently and effectively to obtain maximum benefits of its opportunities. Therefore the research is focused on investigating how

information technologies can be useful to improve performances of the reverse logistics. The study was included identification of processes in reverse logistics, parties of performing the processes, and then impacts of information technologies on performing reverse logistics processes and associated operations.

This paper presents preliminary findings on reverse logistics with original equipment manufacturers. The data were collated through a postal questionnaire survey with randomly selected 310 original business machine and equipment manufacturers in Australia.

II. Literature Review

According to Logistics Management Council reverse logistics is the process of planning, implementing, and controlling efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal (Rogers and Tibben-Lembke, 1999). Considering both upstream and downstream production operations, Fernandez (2003) suggests that reverse logistics can apply to different types of items such as used products, unused products, components, parts and raw materials. On the other hand Dekker and Brito (2002) categorised the returns into number of groups based on the reasons for returning such as manufacturing returns, commercial returns, product recalls, warranty returns, service returns, end-of-use returns and end-of-life returns. However Morrell (2001) is of the opinion that reverse logistics is "the forgotten child of the supply chain" since many organizations do not treat reverse logistics with the same care as traditional (forward) logistics.

Opportunities and reasons for reverse logistics according to Andel (1997) include profits while Roy (2003) suggests economical gains from recapturing some value from raw materials, used components, used products and rejected goods. On the other hand Bayles (2001) explicated reuse of discarded products from commercial returns and excess inventory of products also as opportunities from reverse logistics.

On the other hand, due to emergence of e-business, where customers purchase goods without trying and without touch or feel, more flexible return policy and an efficient reverse logistics system are essential. Smith, Bailey and Brynjolfsson, (2000) and Boyer, Hallowell and Roth (2002) explain that invisibility and physical distance between customer and seller, lack of face to face interaction with customers in electronic businesses and inefficient reverse logistics can destroy customer trust in electronic businesses. Average percentage of customer returns from Internet sales range from 30 to 50 % (Nairn, 2003). Economic gains are important reverse logistics management issue suggested by Roy (2003). This is supported by Kokkinaki, Dekker, Lee and Pappis (2001) who are of the opinion that number of direct and indirect benefits of reverse logistic such as regaining value, achieving a competitive advantage and a positive impact on the environment, are making organizations consider reverse logistics as an essential feature of strategic marketing, effective customer relationship management, as well as environmental protection and sustainable development of manufacturing organizations.

II. 1 Reasons for Performing Reverse Logistics

Important reasons for managing reverse logistics management identified from literature are discussed below.

II. 2 Electronic Business

Electronic business is sale of goods via electronic channels such as the Internet. Customers purchase goods by virtual conceptualisation of size and quality in most online shops. This definitely warrants a large amount of returns forcing organization to have efficient reverse logistics system (Trebilock, 2002). Similarly Sarkis et al (2004) suggest that growth of electronic business has precipitate the need of efficient and effective reverse logistics management. On the other hand Bizrate.com (1999) reported that 94% of online buyers commit to purchase due to protection of product return policy. This is astonishing as estimated average percentage of customer returns in Internet sales is accounted for 30 to 50 percent (Nairn, 2003; Mason, 2002; Sharma, Wickramasinghe and Singh 2005; Rogers and Tibben-Lemke, 1999). Predicted business to customer [B2C] Internet sale in the Asia Pacific region in 2006 is estimated to be US\$ 210 Billion. Jupiter Communication on the other hand estimates a tremendous growth in B2B online transaction, US\$ 6 trillions by 2005 within the USA market, where as described by Brito, Flapper and Dekker (2002) in B2B e-business, the products come back in bulk.

Other reasons for e-business returns according to Lee (2002) are due to errors in ordering, picking or shipping, damages due to transportation handling or cancellation of orders. This is further supported by Haris and Goodman (2001) explaining that growing frustrations among ebusiness customers over, unfulfilled promises, indifference, unrealistic response time, and poorly trained workers are also reasons for higher returns. However, the quantity and

time of the returns arrival are key-questions of both business-to-business and business to customer e-businesses. According to Pan, Ratchford and Shankar (2001) online sales processes comprise pre-sales service, transactions, physical order fulfilments and after sales services. Last two processes are mainly concerned on logistics activities while the last is mostly depended on reverse logistics management.

II. 3 Strategic Marketing and Liberal Return Policies

Strategic marketing and liberal return policies are also major contributors to the growing need for efficient reverse logistics management (Krumwiede and Sheu, 2002). These policies are essential for sales from direct store, catalogue, telephone, television and electronic business etc. Accordingly customers have some control of the product they purchase and develop trust. Higher customer protection legislations allow customers to return products if they are not satisfied Brito and Dekker, (2003) and Krumwiede and Sheu (2002). Customers rightfully, and sometimes wrongfully, take advantage of this opportunity. Therefore businesses are highly vulnerable for higher return rates both online and offline. Dekker et al (2002), identified returns from retail outlets to be 10%, catalogs, telemarketing and the television sales to be 35 percent (Trebilcock 2002) and Internet sales returns to be 30 to 50 percent (Nairn 2003; Mason 2002; Sharma et al 2005). Similarly customer protection regulation and competition among vendors, also lead unlimited returns, which require additional logistics management strategies (Rogers and Tibben-Lembke, 1998).

II. 4 Commercial and Warranty Returns

Commercial returns in reverse logistics denote product returns due to non satisfaction with business transaction process or product quality (Lee, 2002). The commercial returns start from two destinations. Retailer returns products to manufacturers and customers return products to manufacturer via a retailer. Brito et al (2002) described that, financial risk transferability from the buyer to the seller and roles and position of different parties in the supply chain are the key factors, which control volume and quality of commercial returns. Warranty returns include products that failed during use or damaged during delivery from manufacturer to buyers. Similarly commercial and warranty returns include returns due to product mismatch, safety concerns and manufacturer recalls.

II. 5 End of Life and End of Use Returns

Brito et al (2002) suggest that end of use or end of scheduled life returns also require efficient reverse logistics management. This occurs once a product's scheduled life is complete which may include such as end of lease or contract and end of life of a product, or when the product can't be used for primary function. For end-of-use returns, the challenge is determining the match between demand for used products and the supply, impacted by time, quantity and quality. Therefore Sarkis, Meade and Talluri, (2004) suggest an effective and efficient reverse logistics

management system, which provide information through the Internet channel.

II. 6 Environmental Protection and Legal Regulations

Returns have triggered a growing interest in reverse logistics in recent years due to environmental protection, competitive advantage and for regaining value (Brito et al, 2002). Legal regulations in returns management are becoming strict in countries like Germany, Netherlands, Europe, USA and Japan are due to negative effects of wasting energy and resources, pollution of air, water and environment (Fernandez, 2003). As a result, these governments have imposed disposal tariffs and bans, placed restrictions on waste transportation, waste prevention and emission which have increased producers' responsibility to manage returns effectively (Krikke, Pappis, Tsoufas and Bloemhof-Ruwaard, 2001). The challenge here is managing of upcoming out-dated computers for example. The number of personal computer returns is predicted to be 500 million units by 2007 in the U.S.A. As electronic products are the source of many toxic substances such as lead, mercury, cadmium, chromium and bromine these products are ranked as the fastest-growing category of solid waste by the Environmental Protection Agency (Kokkinaki et al, 2001; Europa, 2000). Accordingly, disposing of returned personal computers has become a good example of a product for which reverse logistics is essential for protecting environmental as well as recapturing value or asset recovery, however, more importantly for environmental protection.

II. 7 Economic Gains

According to Brito et al (2002) effective reverse logistics management support economic gain or regaining value from reuse of products or parts or recycling materials. Lund (1998) and Roy (2003) described that over 70,000 re-manufacturing firms in the U.S.A. typically for jet and car engines, auto parts and copiers are relying on reverse logistics to recover value from the reuse of products, modules, parts, components or recyclable raw materials. As a result manufacturers are able to provide quick and better customer service with a shorter lead-time and lower operating margin using the recovered material, part, component and modules (Roy 2003). The increased emphasis on new products and product "freshness" also warrant a clear distribution channel requiring an efficient means of bringing back obsolete, outdated and clearance items. This according to Roy (2003) is seen with Xerox replacing or upgrading hundreds of office printing machines every month. As a result, Xerox is able to act quickly to provide state of the art technology so as to retain their customers.

II. 8 Customer Loyalty and Retention Rate

Potential benefits of strategic reverse logistics management identified by Jiang et al (2005) and Sharma et al (2005) are increased customer retention rates, increased customer loyalty which leads to positive word of mouth, increased exist barriers for their customers. Jiang et al further illustrate

that a customer retention rate of 5% could increase company profit to from 25 to 95 percent. Retention of online customers especially is highly important because online shoppers can a new shopfront with the click of a mouse. As cited in Jiang et al (2005), Boston Consulting Group estimates acquiring a new customer to online channel cost US \$82 compared to US\$38 for store based sale and US\$11 for catalogue-based sales. Further, They emphasised that excellence in physically delivery of services in forward logistics and reverse logistics of an electronic businesses could create a powerful competitive differentiation. It is therefore important to investigate how organizations can strategically manage this increased volume of returns.

II. 9 Barriers of Reverse Logistics Management

Although the importance of reverse logistics is clearly highlighted in the discussion above, there a number of barriers identified from literature. These are discussed in the following section.

Firstly reverse logistics has not been given the same importance as forward supply chain due to a lack of understanding about return management benefits by the organizations (Lee, 2002). Accordingly companies ignored allocating necessary resources for proper management of reverse logistics. Tibben-Lembke (2002) touted that electronic businesses have suffered greatly due to an under estimation of difficulties in determining the physical and psychological values of reverse logistics. This view is supported by Spiegel (2000) describing that some electronic businesses lose 70% of their time due to lack of technologically advanced collaboration and automation of all aspects of logistics operations. In addition Rogers et al (1998) identified reverse logistics barriers to be a lack of importance of reverse logistics relative to other issues, company policies, a lack of information systems, competition, management inattention, financial resources, personnel resources and legal issues.

II. 10 Lack of Modern Information Systems

Commercial software specifically designed to support reverse logistics is not yet available (Caldwell 1999). Similarly Nagel and Meyer (1999) emphasized that a lack of information causes bottlenecks, which leads to difficulties in systems resulting in substantial loss to companies. Zhao (2001) highlighted that a lack of technology-supported systems for reverse logistic processes result in delays, higher costs for operations, invisibility of returned products handled by third parties, repeat operations leading to additional cost to manufacturer and, unawareness and inattention of partner process. Due to the unavailability of dedicated information systems to identify validity of returned products at the point of entering leads to some illegal returns. For example, "non-defective returns" can actually account for 55% or more of the total returns (Lee, 2002). An ill-managed reverse logistic operation can have substantial adverse effect on the profit margin due to waste of resources for process management and rework.

Jiang et al (2005) and Sarkis et al (2004) pinpoint that properly integrated web base information system could link all departments including reverse logistics of electronic businesses as a value network to share information and communication accurately, in a timely manner and rapidly with little effort. Consequently these businesses could manage replicating efficiency in reverse logistics with the speed, accuracy and convenience so as to maintain higher reliability, resilience and innovativeness. Increasingly, pervasive, collaborative communications and information sharing and transparent multi-enterprise network could help to minimize the drawbacks experienced in the reverse logistics management processes (Harris and Goodman, 2001). Sharma et al (2005) also suggest that developing a web based information system for reverse value chain is a challenge that will entail essential competitive advantages as it could integrate many different business processes and stakeholders.

II. 11 Poor Management of Intermediaries

Since returns are mostly handled by third parties differences with reverse transportation and in-house carriage lays difficulties to schedule the best trip for vans, trucks or other means of conveyance, both in terms of money and time. Similarly it is also not always easy to predict the exact amount of material in a certain collection center (Carella et al, 2002). However Krumwiede and Sheu (2002) emphasized that lack of guideline and lack of collaborative information sharing facilities are barriers for effectively manage intermediaries of reverse logistics. Therefore the returns are invisible from the information systems, they are not fully utilized and/or not considered for next business operations till physically arrived to store in unknown time. But the manufacturer has to bear all costs and loses involved in holding, and lost opportunity during this period (Zhao 2001).

II. 12 Meeting Recovery Deadline

According to Carella, et al (2002) an efficient model of reverse logistics is vital for companies that produce for make-to-order contract or repair large industrial machineries, like conditioner, heating plants, train, ship, airplane or its components for their clients. Because without a better model they are unable to respond to their customers in a timely manner and help them avoid shortages. However, failing to do so could lead to huge penalty costs to the company.

II. 13 Conceptual Model for Reverse Logistics Management

Based on the issues discussed above, it is apparent that an effective reverse logistics model is essential. To capture business value and efficiencies in reverse logistics it is important to understand the processes of reverse logistics. It was noted that although different aspects of reverse logistics were mentioned in different publications, a logical and comprehensive presentation of the processes showing the logistics of returned goods has not been addressed.

Therefore from the review of literature a conceptual model for the management of reverse logistics is developed and presented as Figure 1. It provides a comprehensive illustration of reverse logistics management processes and operations.

The reverse logistic processes and their relationships, included in figure 1 have been identified from literature and by analyzing previous models addressing certain aspects of reverse logistics. The conceptual model is a comprehensive model for reverse logistics management.

Recovery processes included the conceptual model were identified from previous models. Kokkinaki, Dekker, Nunen and Pappis (1999:2000) included four recovery operations; redistribution, reuse, remanufacture and recycle. Thierry et al (1995) presented a model with resale, reuse, repair, refurbish, remanufacturing, cannibalization, recycling, landfill, and incineration recovery processes. Fleischmann et al (2002) identified the processes of redistribution, reuse, repair, refurbish, recycle and landfill in their reverse logistics model. Lee (2002) discussed resale, reuse, refurbish, and retrieval as return recovery options of his model. Krikke et al (2001) and Roger et al (1998) identified redistribution, resale, reuse, upgrade, remanufacture, refurbish, recycle and landfill as recovery operations of their models. Brito et al (2003) recognized seven recovery operations for their model; redistribution, reuse, repair, remanufacture, refurbish, retrieval and recycle. De Koster, de Brito and van de Vendel (2002) included repair, remanufacture, refurbish, retrieval, recycle and landfill as recovery operations of their model. The reverse logistics model of Lonn and Stuart (2003) described redistribution, resale, repair and landfill as recovery operations while Meade and Sarkis (2002) models consists reuse, remanufacture, recycle and landfill recoveries. Kokkinaki, Dekker, Koster and Pappis (2001) and Kokkinaki, Dekker, Lee and Pappis (2001) included redistribution, resale, reuse, remanufacture, recycle and landfill as recovery operations in the reverse logistics model. Accordingly a conceptual model for reverse logistics management (Figure 1) was developed.

This model (Figure 1) includes three main sections:

- forward logistics operations,
- preliminary reverse logistics operations and,
- Reverse logistics recovery operations.

Forward logistics section;

This is basically the traditional supply chain through which finished products are passed from manufacturer to final customer.

- production [u], warehouse [v], distributor [w], wholesaler and retailer [x] and, customer [y].

Preliminary reverse logistics operations;

This represents the preliminary operations, which take place from the time a customer or dealer decides to return a product or products till the product(s) are to be reprocessed through one or more recovery processes. Seven preliminary recovery processes were identified from the literature.

- inform [a], return authorization [b], gate keeping [c], collection [d], inspection [e], selection [f] and, sorting [g].

Reverse logistics recovery operations;

Methods of returned products reprocessed are considered as recovery processes. Thirteen recovery processes were identified from the literature review based on the level of changes made on and methods of handling of the returned product(s).

- redistribution [h], resale [i], reuse [j], donate [k], upgrade [l], repair [m], refurbishing (module level recovery) [n], remanufacturing (component level recovery) [o], retrieval (selective part level recovery) [p], recycling (material level recovery) [q], hazard waste management (material level recovery) [r], incineration (energy level recovery) [s] and, landfill (environment recovery) [t].

Arrows in Figure 1 show the flow of returned goods. Returns commence at point [a] and flow to [g]. From [g] the returned goods flow to points [h], [i], [j], [k], [l], [m], [n], [o], [p], [q], [r], [s] and, [t] according to recovery decisions made in the first five preliminary operations [a, b, c, d, e, f and g]. From product recovery operations [h], [i], [j], [k] [l] and, [m] goods flow to [v] [w] [x] and [y]. Outcomes of module, component, part, material and hazard waste recovery operations flow to [u], [m] and [l] via the warehouse. This indicates that any part recovered from reverse logistics is either used for the production of other goods or used to repair or upgrade products. Some goods may be selected for [s] and [t].

The above ideas have been put together in figure 1 to show the sequence the processes occur. As shown in the proposed model (figure 1), reverse logistics begins at point [a]. Any partner of the forward supply chain [u, v, w, x and y] can take the decision to return goods due to commercial and warranty issues, end life and end of use issues, environmental issues, sustainable development issues and strategic marketing and retailing policies. The partner or the customer then informs the manufacturer or its agent of the decision.

All of the above discussed recovery operation depends on product life and the level of depreciation. Brito and Dekker (2003) identified three kinds of product depreciation; intrinsic, homogeneity and economic. Intrinsic deterioration is age of the product. Homogeneity deterioration is age of a product's parts and economic deterioration is value of depreciation.

As suggested by Croxton et al, (2001) managing all the above recoveries is a complex task that consists of a number of sub processes. These sub processes can be divided into two groups such as strategic processes and operational processes. Strategic processes address environment and legal, gate keeping, disposition guidelines, manage return flow, credit handling and secondary markets. Operational sub processes manage returns on ground such as preparing to accept returns, receiving returns, recovery decisions,

customer and supplier credit management and analyzing returns. Further according to them these two groups of processes require an interface to cover customer service and relationship management, demand management, order fulfillment, manufacturing management, supplier relationship management and product development management. All this processes and their relationships emphasize the importunacy of having very effective and efficient information management system.

The conceptual model also includes issues identified from literature such as information management (Zhao 2001; Spiegel 2000; Lee 2002; Caldwell 1999; Brito et al 2002; Sarkis et al 2004), strategic marketing, liberal return policies and customer management (Bruto et al 2003; Krumwiede et al 2002; Rogers et al 1998), environment protection and legal regulation (Bruto et al 2002; Fernandez 2003; Krikke et al 2001; Kokkinaki et al 2001; Europa 2000; Yeldham 2003), intermediaries management (Carella et al 2002; Krumwiede et al 2002; Zhao 2001), meeting recovery deadlines (Carella et al 2002), economical gains (Andel 1997; Brito et al 2002; Lund 1998; Roy 2003) and higher customer or dealers loyalty and retention rate (Jiang et al 2005; Sharma et al 2005, Roy 2003, Brito et al 2002). Further it also aimed to investigate how modern information technologies can be useful to provide better service in reverse logistics management in all types of business models specially which has higher return rate such as retail store and off line business models returns 10 percent (Dekker and Van der Laan, 2002), catalogs, telemarketing and the television models returns 35 percent (Trebilcock 2002) and Internet sales returns 30 to 50 percent (Nairn 2003; Mason 2002; Sharma et al 2005).

Instead of considering all varieties of products together the research is focus on computers and business machines and equipments due to a number of reasons such as comparatively higher percentage of return as a product category 8.5 percent (Rogers and Tibben-Lembke 1998) and nature of machine and equipment such as shorter lifetime of products, higher depreciation rate, high opportunities for secondary market or secondary usage, varieties of basic and additional warranties, huge amounts of used products being disposed, ever expanding market volumes of dealing, perishable nature of goods, high information requirements, high variability and cascade reuse opportunities, and also due to expensive products replacements (Fleischmann et al 2002; Roy 2003; Rogers and Tibben-Lembke 1998; Trebilock 2002; Dekker et al 2002). Therefore this information highly emphasized the necessity of a better reverse logistics system for effective and efficient management of returned machines and equipments. Therefore the research is focused on Australian computer and business machine and equipment manufacturing organizations.

To validate the model research with manufacturing organisations and e-business organisations is undertaken via surveys.

III. Research Approach and Methodology

Research presented in this paper is with manufacturing organisations accomplished via a postal questionnaire survey. The survey questionnaire included a list of carefully structured questions chosen after careful testing for the purpose of eliciting reliable responses (Hussey and Hussey, 1997). It is a positivist methodology whereby a statistical sample is drawn from the population of subjects to make deduction about the population (Collis et al 2003). The survey study was planned to identify and investigate preliminary recovery processes for reverse logistics practiced by the Australian original equipment manufacturers. According to Cavana et al (2001) use of a postal questionnaire survey is more appropriate to gather large amount of data statistically sampled from a survey population, which represent a large geographical area. Therefore the postal questionnaire survey was the most suitable methodology for this research. In addition some other considerations such as budget constraints, time constraints, geographical limitations, and width of the sample frame, were also taken into account when selecting this methodology.

The postal questionnaire was pre-tested with thirty-eight researchers. Based on suggestions of nineteen responses the questionnaire was modified. Modifications included change of question format and the wording for better understanding. The questionnaire survey collated data from a sample of randomly selected 310 Australian original “business machine and equipments” manufacturers which had over Aus\$ 1 million annual income. The manufacturers were randomly chosen from two national business directories (The Business Who's Who of Australia, May 2005, <http://bww.dnb.com.au/> and IBIS World of Australia, May 2005, <http://www.ibisworld.com.au>). A sample of 310 manufacturing organizations was based on the views of Cavana et al (2001), and Sekeran (1992; 2000; 2003) who suggest that sample sizes larger than 30 and less than 500 are appropriate for most research. Original “business machine and equipments” manufacturers were selected as the sample population for this research as they are bound to accept the returned products and provide after sales services due to number of reasons discussed in literature review.

A total of 51 usable responses were received. Response rate 16.45% was contemplated to be reasonable based on the view of Collis and Hussey (2003) that 10% or less response rate of postal questionnaires was not uncommon.

IV. Data Analysis

Data analysis included in this paper was tabulated to show some preliminary findings. The data elicited through the survey were collated from Likert Scales, which are commonly used in business research for useful conclusions (Sekeran 1992; 2000; 2003). Tabular methods of

presentation of the data gathered from the postal questionnaire were summarised and analysed using SPSS, a statistical analysis software package.

V. Findings

Findings of the research date and discussions are presented reflecting issues associated with reverse logistics, information management and information technologies. It also includes findings about reverse logistics performances, market information, product life span and returned products reprocessing time. Some reflections on income and costs are also included. Other issues discussed include business selling models, benefits and barriers of reverse logistics, leadership issues and technologies applied in managing reverse logistics information by the Australian original equipment manufacturers.

Responses were summarised into five categories based on the type of products shown in column one of Table 1. Column two indicates the extent of reverse logistics in each industry. It is clear from Table 1 that large numbers of respondents were electronic and electrical equipment and parts manufacturers, and automotives and parts manufacturers. Both of these product categories represent almost seventy percent of total respondents, while other three categories accounted for remaining thirty percent. Although the numbers of respondents in last three products categories were low, they indicate that reverse logistics is practised in these industries.

From the findings in columns one and two of Table 1, it is apparent that reverse logistics is an important business process. From this information it is clear that nearly 75% of responding manufacturing organizations perform reverse logistics.

Performing reverse logistics could be comparatively easy if the organization's customer base is limited to a smaller geographical area. However from the Table 1, it is clear that large numbers of manufacturing organizations operate globally although they have an important role in the national market of Australia. This indicates that reverse logistics is not only for the local market, but for international returns as well. Therefore management of returned product information is essential for the provision of an effective reverse logistics service.

In Table 2, we present product categories with short and long life spans (three years or fewer and over three years), and the time taken by the organisations to reprocess returned products. It is clear from Table 2 that products with longer life spans are bound to be returned more than those that have a short life span. However, products with shorter life spans are also returned and thus require more stringent reverse logistics management strategy to avoid loss of value from depreciation. Similarly, Table 2 shows that processing time for most of the returned goods is less than a week. However, average return reprocessing time of a returned good just over 3 weeks indicating that a returned product has to spend an average of 2% of its life in reverse logistics processes. While

the goods are in the recovery processes neither manufacturers nor customers receive any benefit or utility from these items, instead it is accounted for depreciation. To achieve value from the returned goods it is essential to minimise the processing time.

Table 3 outlines the cost of reverse logistics by comparing it to organizations' annual income. According to data in Table 3, it is seen that although organizations have annual incomes of up to Aus\$ 100 million, the cost of reverse logistics is only 2% to 3% of annual income. This clearly indicates that reverse logistics is not an important business process in these manufacturing organisations. Findings indicate that the Australian manufacturing organisations are paying poor attention to reverse logistics and thus losing out on substantial opportunities by ignoring reverse logistics.

Table 4 lists the business models that the respondents use to sell their products. The last three columns of the Table 4 show the usage of different business models in each market. It is important to note that the respondents were allowed to select more than one business model if applicable. It is clear from Table 4, that wholesaling (84%), retailing (63%), telephone (63%) and catalogue (57%) business models are largely used by manufacturing organizations in Australia to sell their products in regional, national and global markets. It is important to note that, B2B and B2C e-business business models are not as popular as expected, especially to reach out to global customers.

The respondents were allowed to select more than one business models if applicable. From the data, it is shown that 89% use two or more business models to distribute their products while 55% use four or more strategies. Therefore it is inferred that for all business models reverse logistics processes have to be put in place to manage returns. To manage returns from several selling models an efficient information management system would be useful.

Reasons for performing reverse logistics and their importance indicated in percentages are presented in Table 5. It is important to note that the respondents were allowed to select more than one reason for reverse logistics if applicable. According to data in Table 5, the two most important reasons for reverse logistics are customer service (84%) and strategic (73%) such as goodwill and brand image. Competition is another reason, while some less important ones are law, legal disposal requirements, recapturing value and assets and a clean channel.

Company image and goodwill are the most important benefits of reverse logistics identified from this research. Other reasons are competitive advantage, recapturing value from components and legal obligations. As seen in Table 6, recapturing value is important for only half the respondents, and this could be the reason for the less importance given to reverse logistics, or on the hand this could also indicate that if the reverse logistics processes are better managed, more value could be captured from returned goods.

In Table 7 we present a list of barriers for reverse logistics and percentage as indicated by the respondents. The

respondents were allowed to select for more than one barrier for reverse logistics if applicable. According to Table 7 the three main barriers for reverse logistics are low importance compared to other business processes, improper information management and a lack of personnel resources. It is imperative to note that the barrier of unavailability of efficient and effective reverse logistics information management systems has been identified as the second most important barrier for reverse logistics by the manufacturing organizations in Australia. This finding is supported by the literature (Zhao 2001 Lee 2002; Sarkis et al 2004; Spiegel 2000 and Rogers et al 1998) which identified that a lack of information system as a main barrier. This implies that application of effective information systems will drastically improve the reverse logistics information management for capturing value.

Other less important reasons are a lack of interest from the management, not having company policies in place to support reverse logistics, and poor partnerships to manage the processes.

According to data in Table 1 it is apparent that reverse logistics in most organisations is the responsibility of the operations manager. Manufacturing managers and marketing managers also are given the responsibility in some cases. However, a dedicated reverse logistics manager is not a position in any of the organisations implying that it is not very important.

List of technologies used in reverse logistics management are shown in Table 9. According to Table 9, the most important technologies supporting reverse logistics are telephone, fax and computers. Mobile technologies are being applied as well together with other technologies.

This implies that information technologies have a very important role in collating and processing reverse logistics information.

However according to Table 9, it is clear that most of the information technologies such as Internet, extranet, ERP, barcode and EDI, are not fully exploited for reverse logistics management. Therefore the responded manufacturing organizations have to take strategic action for incorporating these technologies that could facilitate online real time reverse logistics information management. Because it could help manufactures to receive number of benefits of efficient information management such as minimum waiting time for information, minimum use and waste of resources [such as papers, envelopes, money and labour], higher efficiency in information sharing and exchange, online conference and decision making. Similarly implementation of online real time reverse logistics information updating, managing, updating and sharing system will enhance quality of managing customer service and reverse logistics.

VI. Discussion

From the data presented above it is clear that reverse logistics is important for industries manufacturing electrical and electronic goods and automotive parts more than other

industries. It also highlights that reverse logistics is an important business process for goods sold in regional, national and international markets. Finding indicate that products with a longer life span are more likely to be returned and require reverse logistics management more than products with short life spans. The most important reasons identified for reverse logistics are customer service, strategic and competitive reasons.

Although anecdotal evidence indicates recapturing value from returned goods to be an important reverse logistics benefit, this research indicates that company image and goodwill to customers are more compelling benefits. The most important barrier identified is the diminutive role of reverse logistics in companies. Ad hoc information management methods, a lack of resources and top management support are other important barriers to reverse logistics in the Australian manufacturing industries.

This research highlights that in most organisations reverse logistics is the responsibility of the operations manager. This implies that reverse logistics is not important or large enough to warrant a role for its management or department. It is very clear from this research that a large number of technologies are used to manage reverse logistics in Australia. This implies that at this stage there is no dedicated system for the management of reverse logistics.

VII. Conclusion

This is a research in progress paper, which has discussed some preliminary findings. Issues identified from a review of literature on reverse logistics have highlighted its importance and ability to capture value. An analysis of models addressing different aspects of reverse logistics have been comprehensively put together to show the flow of processes and information to maximise value. However, research findings indicate that manufacturing organisations have not realised the value of reverse logistics and have not given it the same importance as other processes. Hence to some extent it still is 'the forgotten child of supply chain'.

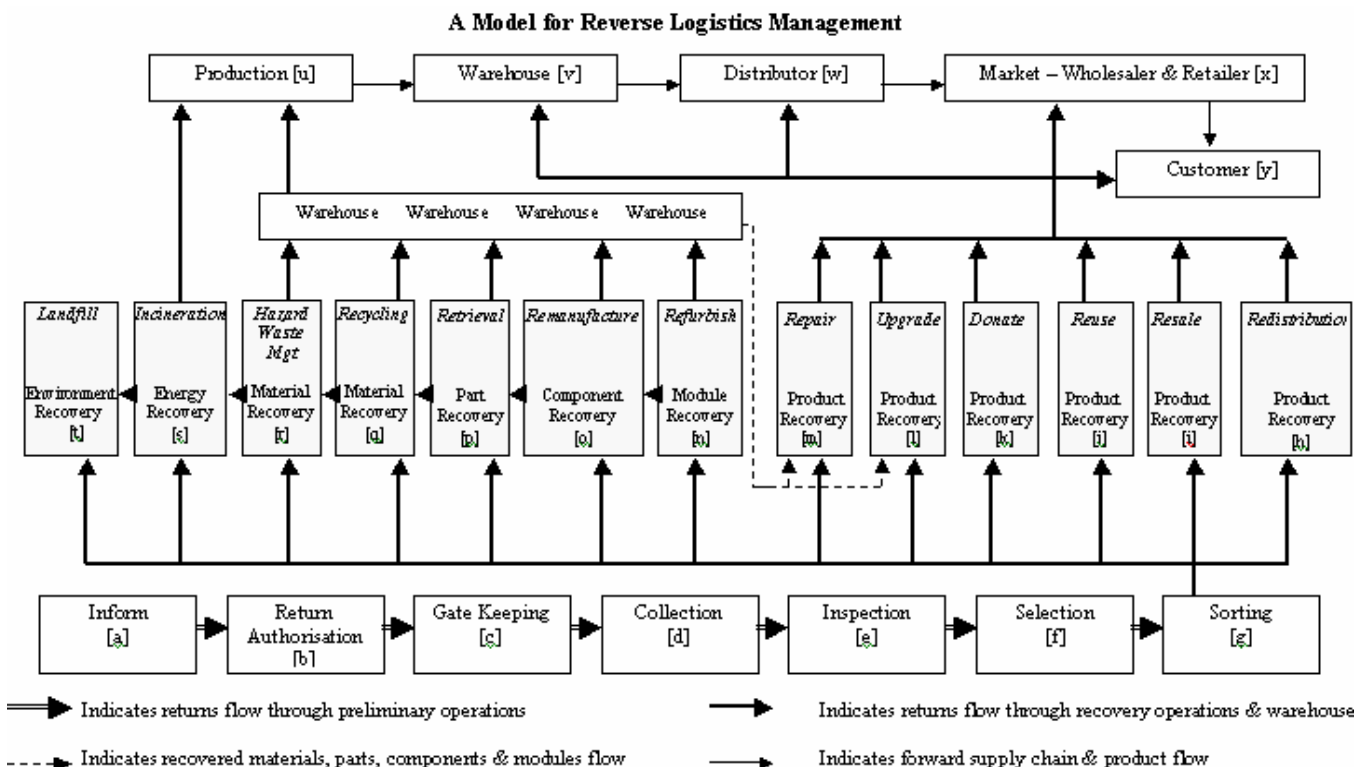
The next phase of this research will explore reverse logistics in the e-business space as literature indicates that returns from e-business purchases are very high.

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Figure 1: Conceptual Model for Reverse Logistics Management



Product Categories	Responses (Percentage)	Co's Performing Reverse Logistics		Geographical Area of Market		
		Yes (Percentage)	No (Percentage)	Global (Percentage)	National (Percentage)	Regional (Percentage)
Electronic and Electrical Equipment and Parts	43.14	77.27	22.73	47.06	23.53	29.41
Automotives and Parts	25.49	76.92	23.08	70.00	20.00	10.00
Mining and Irrigation Equipment	11.76	83.33	16.67	80.00	20.00	0.00
Construction Equipment	11.76	50.00	50.00	66.67	33.33	0.00
Medical and Scientific Equipment	7.84	75.00	25.00	66.67	33.33	0.00
Overall		74.51	25.49	60.53	23.68	15.79
Total	100.00	100.00		100.00		

TABLE 1 Product Categories, Performance of Reverse Logistics and Geographical Area of Market of the Respondents

Product Categories	Product's Life Span		Returned Reprocessing Time [Weeks]			
	3 years or less (Percentage)	Over 3 years (Percentage)	Less than 1 (Percentage)	1 to 4 (Percentage)	4 to 8 (Percentage)	Over 8 (Percentage)
Automotives and Parts	50.00	50.00	60.00	40.00	0.00	0.00
Medical and Scientific Equipment	33.33	66.67	33.33	33.33	33.33	0.00
Electronic and Electrical Equipment and Parts	11.76	88.24	23.53	58.82	5.88	11.76
Construction Equipment	0.00	100.00	66.67	0.00	0.00	33.33
Mining and Irrigation Equipment	0.00	100.00	0.00	60.00	0.00	40.00
Overall	21.05	78.95	34.21	47.37	5.26	13.16
Total	100.00		100.00			

TABLE 2 Products life span and reprocessing time

Product Categories	Annual Income Aus\$ Millions			Annual Reverse Logistics Cost Aus\$ Millions	
	100 or less (Percentage)	101-250 (Percentage)	Over 250 (Percentage)	5 or less (Percentage)	Over 5 (Percentage)
Construction Equipment	100.0	0.0	0.0	100.0	0.0
Medical and Scientific Equipment	100.0	0.0	0.0	100.0	0.0
Electronic and Electrical Equipment and Parts	70.6	17.6	11.8	94.1	5.9
Automotives and Parts	60.0	10.0	30.0	100.0	0.0
Mining and Irrigation Equipment	40.0	20.0	40.0	80.0	20.0
Overall	68.4	13.2	18.4	94.7	2.6
Total	100.00			100.00	

TABLE 3 Annual income and reverse logistics cost

Business Model	Percentage of Users	Percentage of Users in		
		Global Marketing	National Marketing	Regional Marketing
Wholesaling	84.21	86.96	77.78	83.33
Retailing	63.16	69.57	66.67	33.33
Telephone	63.16	60.87	77.78	50.00
Catalogue	57.89	60.87	55.56	50.00
B2B ebusiness	39.47	47.83	33.33	16.67
B2C ebusiness	28.95	34.78	33.33	0.00
Other	28.95	34.78	33.33	0.00
Total		60.53	23.68	15.79

TABLE 4 Business models used for marketing

Reasons for Reverse Logistics	Percentage Respondents
Customer service	84.21
Strategic	73.68
Competitive reasons	44.74
Customer protection Laws	23.68
Legal disposal issues	18.42
Recapture value	15.79
Recover assets	15.79
Clean channel	10.53
Protect margin	5.26
Others	2.63

TABLE 5 Reasons for reverse logistics

Benefits	Average Annual Value Aus\$ Mil lion	Percentage Respondents
Goodwill and company image		71.05
Resale of returned goods	0.81	65.79
Competitive advantage		57.89
Recapture value from components	0.24	50.00
Legal obligations		50.00
Environment protection		39.47

TABLE 6 Benefits of reverse logistics

Barriers of Reverse Logistics	Percentage Respondents
Low importance of reverse logistics compared to other issues	28.95
Improper information management	21.05
Lack of personal resources	21.05
Management inattention	13.16
Company policies	10.53
Competitive issues	10.53
Poor partnerships	10.53
Lack of financial resources	5.26
Legal issues	5.26

TABLE 7 Barriers of reverse logistics

Designation	Number of Manufacturing Organization	Perform Reverse Logistics	
		Yes	No
Operations Manager	11	9	2
Manufacturing Manager	9	5	4
Marketing Manager	5	4	1
Logistic Manager	4	4	-
Production Manager	3	3	-
Supply Chain Manager	2	2	-
General Manager	4	1	3
Business Manager	1	1	-
CEO	1	1	-
Director	1	1	-
Distribution Manager	1	1	-
Engineer	1	1	-
IT manager	1	1	-
MRP controller	1	1	-
Plant Manager	1	1	-
Product Manager	1	1	-
Public Relation Manager	1	1	-
Accountant	1	-	1
Quality Manager	1	-	1
Sales Manager	1	-	1
Missing	9	-	-
Total	60	38	13

TABLE 8 Reverse logistics leadership

Technologies	Percentage of Users
Land Telephone / Fax	97.37
Computers - Laptop / Desktop, Servers	92.11
Mobile phone / PDA / Other Palm device	65.79
Intranet	55.26
Tracking & Tracing System	47.37
ERP- Enterprise Resource Planning	39.47
Barcode & Scanning System	34.21
Data Mining & Data Logging System	34.21
Extranet	28.95
Internet-B2B standard	28.95
Electronic Data Interchange-EDI	28.95
Internet-B2C standard	26.32
Decision Support System	18.42
Global Positioning & Geographic Information System	7.89
Radio Frequency Identification -RFID	5.41

TABLE 9 Technologies used to manage reverse logistics

Power, Relationship Commitment and Supply Chain Integration Between Manufacturer and Supplier

Baofeng Huo *, Xiande Zhao **, Jeff Hoi Yan Yeung ***

Department of Decision Sciences and Managerial Economics, Faculty of Business Administration

The Chinese University of Hong Kong, Shatin, N.T., Hong Kong

* Tel. 852-2609-8560 Email: baofeng@baf.msmail.cuhk.edu.hk

** Tel. 852-2609-7650 Fax: 852-2603 6840 Email: xiande@baf.msmail.cuhk.edu.hk

*** Tel. 852-2609-7779 Fax: 852-2603 6840 Email: Jeff@baf.msmail.cuhk.edu.hk

Abstract: This study identifies the factors that influence supply chain integration between manufacturer and suppliers and develop the measurement instruments for them. The factors influencing supplier integration include mediated power, non-mediated power, normative relationship commitment, and instrumental relationship commitment among the trading partners. This study empirically investigates the relationships between the factors that influence supplier integration, the degree to which the suppliers are integrated, and supplier and manufacturer's performance within the supply chain using data collected from manufacturing companies within the supply chains from Mainland China and Hong Kong. This study also empirically tests the reliability and validity of the instruments. The results show that two types of power impact relationship commitment significantly. Relationship commitment has a positive influence on supplier integration and supplier's performance. Supplier integration leads to manufacturer's financial performance. This study provides important insights for future researchers to understand power, relationship commitment and supplier integration from various perspectives. Findings from the study can help companies enhance their global competitiveness by developing and managing relationships with their trading partners that will enable them to have effective integration of key processes within the supply chain.

Keywords: SCM; Power; Relationship Commitment Supplier Integration; Performance; China.

I. Introduction

Though the fundamental concept and importance of supply chain management are widely accepted by both the scholars and the practitioners, some important areas about supply chain integration are still not described theoretically and processed practically well. For instances, there is no commonly accepted scales on the term "supply chain integration" and there is no concrete descriptions on the factors affecting the supply chain integration. In addition, there is not much research findings on how the initiators affect the supply chain integration, and in what extent the supply chain integration could affect the performance of the

manufactures.

Many papers identified different types of integration of supply chain [33;46;57;62;78;78], Some papers analyzed the relationship between supply chain integration and supply chain performance [62], However, only a few papers explained the initiators of the supply chain integration and the functions of them, and these papers only cited several initiators of the supply chain integration without detailed explanation about the relationships among the initiators, supply chain integration and performance.

Researchers in marketing and management have investigated power and relationship commitment issues within and between organizations over the last decade. Brown, Lusch, & Nicholson [12] empirically tested the impact of power and relationship commitment on marketing channel member performance from the relationship marketing perspective. Maloni & Benton [53] found that power plays a significant role in the supply chain management, and the different sources of power have different impacts on inter-firm relationship in the supply chain. A stronger buyer and supplier relationship can enhance the performance of the companies in a supply chain. Cox [23] illustrated that power is at the heart of the trans-organizational relationships and captive suppliers are conditioned by powerful buyers to make substantial investment (commitment) to sustain the business relationships. Benton & Maloni [6] investigated the supplier satisfaction in power driven buyer-supplier relationships. However, there are few studies investigated the influence of power or relationship commitment in SCI area. Beth et al [7] advocated that relationship commitment are placed in the highest priorities in achieving "supply chain integration", a significant concept that promotes collaboration between supply chain partners for values and competitiveness.

We aim to find the factors that play an important role integration of the enterprises, Such as power, and relationship commitment. This study identifies the key factors that influence supplier integration, develops and tests a conceptual framework that can explain the relationships among the key driver variables and process integration, and the performance of the firms within the supply chain. So, the objective of our study is to build a model to identify the relationships among power, relationship commitment, supplier integration, and company performance. It also presents an overview of the manufactures in Mainland China and Hong Kong. Specifically, the objectives of this study

are: 1). to offer a comprehensive review of power, relationship commitment, supply chain integration with supplier, and company performance. 2). to identify the key factors that influence supply chain supplier integration. These factors include power, and relationship commitments, etc. 3). to develop a measurement instrument for the above factors, supplier integration, and the performance of the firms within the supply chain. 4). to propose and test a model that represents the relationships among the factors that influence supplier integration, the degree of supplier integration, and firm performance. 5). to provide guidelines for companies to enhance their performance through better relationship management and process integration.

The paper is organized as follows: firstly, we review some related literatures related to power, relationship commitment, supplier integration, and performance; this is followed by the development of a conceptual model with hypotheses and the explanation of research methodology. The hypotheses are tested, followed by the discussion of the findings. Finally, the conclusions and the limitations of the study are presented, together with suggestions for future research.

II. Literature Review

II.1 Supply Chain Integration

Extensive literature has attached great importance to supply chain integration for achieving comparative advantages [9;22;32;52;56;59;72], as well as operational performance [1;3;33;46;61;78]. Various literatures [9;41] suggested that supply chain integration are to integrate the relationships, activities, functions, processes and locations among all channel members in the supply chain. Stevens [80] proposed that integrating the supply chain is primarily involved in planning, coordinating and controlling materials, parts and finished goods from suppliers to customers at all different strategic, tactical and operational levels. In addition, Naylor et al [64] demonstrated that the goal of integration is to eliminate all the boundaries to smooth the flow of material, cash, resource and information. Based on this line of thought, supply chain integration should be strategically managed as a single system as opposed to individually optimizing fragmented subsystems [85]. But, one of the limitations of the earlier explanations is that they may not be systematic enough to differentiate integration from supply chain management.

Supply chain integration could be illustrated as the degree to which the firm can strategically collaborate with their supply chain partners and collaboratively manage the intra- and inter-organization processes to achieve the effective and efficient flows of product and services, information, money and decisions with the objective of providing the maximum value to the customer at low cost and high speed [8; 33; 80; 82; 83]. The objective of supply chain integration is to provide the maximum value to the customer at low cost and high speed. Customer orientation is exceptionally important in current business world.

Without the customer-oriented initiatives, we couldn't expect a successful implementation of supply chain integration.

Supply chain integration could be further identified into six types: strategic integration, relationship integration, internal integration, external integration, information integration and measurement integration. Strategic integration refers to the degree to which a firm can structure the strategic goals and objectives, as well as the sharing of resources, rewards and risks across organizations into consensus and contractual agreements in order to achieve competitiveness [14; 34; 46]. Relationship integration refers to the degree to which a firm can structure the formation, commitment, maintenance and exit of relationships across organizations into consensus and contractual agreements in order to achieve competitiveness [8; 78]. Internal integration refers to the degree to which a firm can structure its organizational practices, procedures and behaviors into collaborative, synchronized and manageable processes in order to fulfill the customer requirement [16; 18; 48; 50]. External integration refers to the degree to which a firm can partner with its key supply chain members (customers and suppliers) to structure their inter-organizational practices, procedures and behaviors into collaborative, synchronized and manageable processes in order to fulfill the customer requirement [79]. Information integration refers the degree to which a firm can coordinate the activities of information sharing and combine core elements from heterogeneous data management systems, content management systems, data warehouses, and other enterprise applications into a common platform in order to substantiate the integrative supply chain strategies [45; 74]. Measurement integration refers to the degree to which a firm can structure the measurement systems and manage the measurement activities with its key supply chain members in order to substantiate the integrative supply chain strategies [8].

Frohlich et al [33] investigated supplier and customer integration strategies in a global sample of 322 manufacturers. Scales were developed for measuring supply chain integration, and five different strategies (inward-, periphery-, supplier-, customer-, and outward-facing) were identified in the sample. Morash et al [57] investigated and compares 3 major forms of supply chain integration for approximately 2 thousand global firms. The 3 forms of supply chain integration include intra-organizational process integration, inter-organizational collaborative integration including strategic alliances, and operational excellence. This paper identified two types supply chain integration: external (customer and supplier) and internal (process reengineering) integration.

The measurement and empirical studies of supply chain integration can be further divided into two prevalent perspectives. These are 1) as a series of interactions between the competitive environment and the organization and 2) as collaborative behaviors that happened within and across supply chain organizations. In line with the first perspective,

Johnson [46] developed an instrument using data from industrial equipment distributors and empirically validated strategic integration as a center of gravity for building up sustainable integration. The findings revealed that dependence, flexibility, continuity expectations, and relationship age have positive effects on a distributor's strategic integration with its suppliers. Moreover, strategic integration enhanced the distributor's financial performance. However, contrary to common belief, the result suggested that uncertainty did not have a significant effect on the distributors' strategic integration with their suppliers or on performance. Following a second line of thought, Stank et al [79] emphasized internal and external collaboration. On the basis of their findings, it has been suggested that collaboration with external supply chain entities increased internal collaboration, which in turn improved service performance. Although both dimensions can provide insights for managers and researchers in establishing supply chain integration, it is reasonably believed that a composite of the two may better describe supply chain integration in a highly dynamic environment.

II.2 Power

Category management has been promoted as a mechanism to achieve closer working relations between suppliers and retailers. The premise has been that category management should result in a reduced reliance on the use of power as an element of the relationship and increased levels of cooperation. However, Dapiran & Hogarth-Scott [24] suggested that power is an element of any relationship and exists even when not activated and the premise rests on the notion that cooperation is a polar opposite of power. This research confirms that UK and Australian food industry managers perceive the use of power in solely negative terms. Power can be defined operationally as the ability of one channel member to influence the marketing decisions of another channel member and hence must be related to cooperation. This paper reviews the nature of dependence, power and cooperation and explores the role of these constructs in the practice of category management. And a model was suggested that shows the linkages between power, cooperation, capitulation, and trust. The use of mediated power bases of reward and coercion was likely to lead in the immediate term to capitulation. The non-mediated bases of power - expert/ information, referent, legitimate - were likely to lead to the state of existence called cooperation.

Cox [23] illustrated that power is at the heart of the trans-organizational relationships and captive suppliers are conditioned by powerful buyers to make substantial investment (commitment) to sustain the business relationships. The study explained why competence in procurement and supply management must start from an understanding of the bases of supplier power and business strategy and how the power perspective can enhance effective procurement and supply management. The basic power matrix that is essential in understanding the exchange relationship between buyers and suppliers is outlined, so that

buyers can understand the circumstance they are in and what scope exists for them to augment their power relative to suppliers. The study also investigated that procurement and supply competence must involve the buyer seeking ways to eradicate augment the power of the supplier over the buyer, as well as seeking at all times to ensure that its suppliers operate only in highly contested markets and earn only normal returns. It was important to understand that the power attributes that may be available to buyers and suppliers can be double-edged. This was because a power attribute may favor the buyer and sometimes it may favor the supplier. The paper also explained how regulation can be an attribute that augments the power of both the buyer and the supplier.

Benton et al [6] investigated the supplier satisfaction in power driven buyer-supplier relationships. They examined the influences of supply chain power on supplier satisfaction and the impact of buyer-seller relationship on supplier satisfaction. Three primary objectives were achieved in this study: 1) how the different "bases of power" affect the satisfaction of selling firms? 2) how power driven relationships affect supplier satisfaction, and 3) how to measure the effect of power influences on supplier satisfaction in the automobile industry. The power-affected buyer-supplier relationship was found to have a significant positive effect on both performance and satisfaction. But they failed to find the casual relationship between performance and satisfaction.

Maloni et al [53] examined the detrimental and beneficial effects of power on the ability to build integrated, high-performance buyer-supplier relationships in the supply chain. The study found that power plays a significant role in the supply chain management, and the different sources of power have different impacts on inter-firm relationship in the supply chain. A stronger buyer and supplier relationship can enhance the performance of the companies in a supply chain. Study also validates that supply chain integration is a key element of cooperate strategy and it is very important to understand the process of supply chain integration.

Brown et al [12] empirically investigated the impact of power and relationship commitment on marketing channel member performance from the relationship marketing perspective. They found that in marketing channels for farm equipment, the supplier's use of power may bring two 2 key outcomes: 1). the retailer's commitment to the channel relationship and 2). both supplier and retailer performance within the channel. They also investigated how retailer commitment affects channel members' performance in terms of both supplier's performance and retailer performance. They argued that key linkages are moderated by the symmetry of power within the channel (i.e., whether the retailer is more powerful, power is somewhat balanced between the two channel members, or the supplier is more powerful). Their results partially supported both the primary construct linkages as well as the moderating effect of power symmetry upon them. The study demonstrated that power and its usage can have a pivotal impact on the working

relationships in marketing channels and under certain conditions, the use of power in the channel can enhance performance for all channel members.

Goodman & Dion [37] argued that since Industrial distributors were carrying an increasing percentage of industrial goods in the ways of mergers and acquisitions, they became larger and more powerful. This constrained the ability to product line manufacturers to exercise power over their distributors. But the manufacturers still require commitment from their distributors in order to carry out a coordinated marketing program. Power was becoming one of the important determinants of relationship commitment in the distributor-manufacturer relationship. A model of distributor commitment was developed in this study based on the high-tech distributors surveyed.

Chris [21] stated that the balance of power in an exchange relationship can shift over time to favor the supplier. This paper investigated the importance of asset specificity for buyer-supplier exchange relationships in outsourcing decisions. Emphasis was placed on the need for buyers to understand pre- and post-contractual risks and how asset specificity can lead to post-contractual lock-in or dependency was discussed. The concepts of asset specificity, uncertainty, and information asymmetry were outlined as they relate to the scope for improvement in supplier power.

Watson [86] presented that supply chains are complex power structures in which participants have very definite interests that go beyond cost control through waste management. These interests extend into areas such as that wins from the process of coordination and whether the benefits of coordination fully cover the managerial costs incurred. Customers and suppliers enjoy the power to veto an organization's integrated supply chain management initiative and, as a result, the chances of achieving supply chain integration are reduced. But even in the relationship between the insurers and their preferred car repairers, these preferred suppliers have little scope to leverage value from the branded parts suppliers that dominate the relationship between quality and cost in this sub-regime of the overall power regime.

II. 3 Relationship Commitment

Morgan & Hunt [58] suggested that the propensity for relational continuity and the establishment of long-term relationship are primarily in the theme of "relationship commitment". Relationship commitment can be defined as the willingness of a party to invest resources into a relationship [27; 58]. Gundlach et al [39] further pinpointed its importance for developing and sustaining successful relational exchange.

Relationship commitment can be identified into two levels: interpersonal commitment and organizational commitment. Interpersonal commitment refers to the individual's willingness to contribute considerable time, work and energy for another individual [43]. Organizational commitment could be further categorized

into two: Intra-organizational and inter-organizational commitment. Intra-organizational commitment refers to employee's identification with and acceptance of their organizational goals and values, as well as his willingness to make considerable effort to his organization for a desirable outcome [60; 69]. Inter-organizational commitment is defined as the willingness of a focal organization to invest in the relationship with its partners based on the favorable outcomes [19]. With increased inter-organizational commitment, supply chain organizations would develop closer relationships with their supply chain partners; therefore, it enhances the implementation of supply chain integration. Two types of relationship commitments were identified by Mathieu & Zajac, and Penley & Gould [55; 68]: affective commitment and calculative commitment. Affective commitment can be defined as one party's identification with and emotional attachment to the goals and values of another party, and willingness to secure the relationship [58; 87]. Calculative commitment can be viewed as one party's identification with the benefits and costs of the relational exchange, and willingness of maintaining the relationship for satisfying his needs [36].

Because supply chain integration is created by cooperative, mutually beneficial partnerships with supply chain members [88], there has been an increasing research emphasis on power and relationship commitment in recent years.

II. 4 Performance

As cited by Chen et al [18], a common measure of business performance is financial performance because the primary goal of business organization is to make profits for the shareholders. Financial performance has been widely used as a key measure of firm performance [10; 11] and is evaluated in different dimensions. However, much literature [28; 29; 77] has pinpointed the limitations in relying solely on financial performance measures in supply chains. van Hoek [84] further advocated the supply chain firms to devise innovative measurement system as opposed to the traditional ROI-based system. A broader conceptualization of performance measures includes customer service and other operational indicators. Neely et al [65] presented a few of the categories of performance: comprising quality, time, flexibility, and cost. Vickery et al. [85] included the dimensions of service performance in their customer service construct that are general, and these customer service items include pre-sale customer service, product support, responsiveness to customers, delivery dependability, and delivery speed. Benita [4] presented an overview and evaluation of the performance measures used in supply chain models and also presents a framework for the selection of performance measurement systems for manufacturing supply chains. Three types of performance measures are identified as necessary components in any supply chain performance measurement system, and new flexibility measures for supply chains are developed.

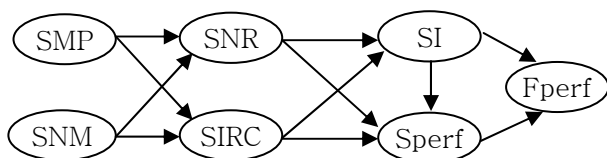
Various literatures [38; 38; 49; 54] suggested that a

balanced approach for the performance measurements is essential to present a clear picture of organizational performance. Actually, some recent supply chain integration studies [81; 85] have used both operational and financial performances as indicators for the organizational performance. However, many supply chain integration studies have measured either operational [75; 78; 79] or perceived financial performance outcomes [73].

In summary, previous research has shown that supply chain integration with suppliers is very important for achieving superior supply chain performance. Additionally, power and relationship commitment have become a promising area of research in supply chain integration literature. However, much of the previous work regarding supply chain integration is U.S.-oriented and has not identified a comprehensive model for business process integration. There is a need for further research to investigate the relationships between the various factors that influence business process integration, the degree to which processes are integrated, and the performance of the firms within the supply chain.

III. The Proposed Model and Research Hypotheses

Based on the literature reviewed and the in depth interviews with more than 15 practitioners who are in charge of supply chain management in Hong Kong and Mainland China, we propose the following theoretical framework for supply chain supplier integration.



Within this framework, we have included the following seven theoretical constructs: (1) Perceived Supplier Mediated Power (Smp), Mediated power, which includes reward, coercive, and legal legitimate, involve influence strategies that the source (buyer) specifically administers to the target (seller). The intention is to bring about some direct action. Mediated bases represent the competitive and negative uses of power traditionally associated with organizational theory [12; 53]. (2) Perceived Supplier Non-mediated Power (Snmp), Compared with mediated powers, Non-mediated power which includes expert, referent, and traditional legitimate are more relational and positive in power orientation [53]. (3) Normative Relationship Commitment to Supplier (Snrc), Normative relationship commitment refers to one member's identification with another member and its internalization of common norms and values with another member [12] (4) Instrumental Relationship Commitment to Supplier (Sirc), Instrumental relationship commitment is based on compliance (driven by rewards or punishment, etc.) and distinct from normative

commitment [12]. (5) Supplier integration (Si), Supplier integration is defined as the core competence derived from better coordination of all the critical suppliers in a company's supply chain to jointly achieve improved service capabilities at lower total supply chain cost [8]. (6) Supplier's performance (Sperf), Supplier's performance is defined as the company's supplier operational outcome, such as the level of quality, flexibility, delivery, and customer service. It should be noted that supplier's performance is concerning the company's performance with respect to its major supplier. It is not the performance of the supplier companies. (7) Financial performance (Fperf). Financial performance is defined as financial and market measures to evaluate the firm's efficiency and effectiveness. We used financial performance to measure the performance of the manufacturer in the supply chain is for that financial performance is a common measure of business performance [18]. On the other hand, we can find that supplier's performance is based on the operation aspects of the companies. Using financial performance as a common measure of the performance of the manufacturer in the supply chain, we can investigate the impacts of supplier's performance on financial performance. These constructs and their relationships were identified based on the results of an extensive review of the related literature and our observations during plant visits and in-depth interviews with executives who are knowledgeable in supply chain management. To identify reliable and valid measurement items for each of the constructs, we have conducted an extensive literature review. Whenever possible, we have adopted from valid measurement items used in previous studies. We have also added some new measurement items and modified some of the measurement items based on the results of our in-depth interviews and observations during the plant visits. The preliminary measurement items for the key constructs and the sources from which these items were adopted are shown in Appendix.

Brown et al.[12] found that in marketing channels for farm equipment, the supplier's use of different power may bring different retailer's commitment to the channel relationship and relationship commitment brings both supplier and retailer performance within the channel. Goodman et al [37] argued power was becoming one of the important determinants of relationship commitment in the distributor-manufacturer relationship. So, we proposed those hypotheses:

H1: Companies with a greater level of perceived supplier mediated power are more likely to have a stronger normative relationship commitment to suppliers.

H2: Companies with a greater level of perceived supplier mediated power are more likely to have a stronger instrumental relationship commitment to suppliers.

H3: Companies with a greater level of perceived supplier non-mediated power are more likely to have a stronger normative relationship commitment to suppliers.

H4: Companies with a greater level of perceived supplier non-mediated power are more likely to have a stronger

instrumental relationship commitment to suppliers.

With relationship commitment, supply chain partners become integrated into their key suppliers' business processes and more tied to established goals [18; 58]. Working in this same vein, Prahinski & Benton [70] developed and empirically tested a model that explained how suppliers perceive the buying firm's supplier evaluation communication process and its impact on suppliers' performance. Johnson [46] investigated the strategic role of inter-firm relationships through the concept of strategic integration. Narasimhan & Kim [63] investigated a set of strategies for information systems utilization in supply chain integration initiatives. It is argued that there might be a recommended sequence in using information systems for supply chain integration. Stank et al [79] developed and tested the measures to examine empirically the relationships between internal and external supply chain collaboration and logistical performance. Daugherty et al [26] empirically examined involvement in reverse logistics activities. The research specifically addressed the relationship between information systems support and reverse logistics program performance. The research examined the role of relationship commitment. Relationship commitment implies closer relationships. Such closer buyer-seller relationships are frequently associated with more positive relationships between information systems support and reverse logistics program performance. Brown et al [12] found that relationship commitment brings both supplier and retailer performance within the channel. So we proposed that

H5: Companies with a stronger normative relationship commitment to suppliers are more likely to have to a greater extent of supplier integration.

H6: Companies with a stronger instrumental relationship commitment to suppliers are more likely to have to a greater extent of supplier integration.

H7: Companies with a stronger normative relationship commitment to suppliers are more likely to have to a greater extent of supplier's performance.

H8: Companies with a stronger instrumental relationship commitment to suppliers are more likely to have to a greater extent of supplier's performance.

The relationship between supply chain integration and performance outcomes is discussed over a vast body of supply chain and operations literature [3] [25; 81]. For example, Stank et al [78] developed and tested an instrument for measuring supply chain integration competences as well as determining their relative importance to developing logistics distinctiveness. Stank et al. [79] suggested that collaboration with supply chain partners facilitates internal collaboration, which in turn enhances logistics performance. Frohlich et al [33] examined the simultaneous effects of five different supplier and customer integration strategies on a broad array of operations performance outcomes based on a global sample of 322 manufacturers. The findings demonstrated that supply chain companies with the widest degree of the arcs of integration achieve the highest level of performance improvement involving the customer service,

on-time delivery, delivery lead time, productivity, quality, and cost, in addition to the market share and profitability. Armistead et al [3] identified the extent to which greater integration along the supply chain leads to improved operating performance. A survey was conducted of managers from companies that participated in the UK Best Factory Audit conducted by Management Today and Cranfield School of Management. So we proposed those hypotheses

H9: Companies with a greater extent of supplier integration are more likely to have a greater extent of supplier's performance.

H10: Companies with a greater extent of supplier integration more likely to have a greater extent of financial performance.

H11: Companies with a greater extent of supplier's performance more likely to have a greater extent of financial performance.

IV. Research Methodology

IV. 1 Sampling and Data Collection

To test the above hypotheses, we collected data from manufacturing companies in Hong Kong and Mainland China. Since China is becoming the global factory of the world, manufacturing companies in China play a very important role in many supply chains. To our knowledge, there are no solid empirical studies of supply chain management issues using data from China. Therefore the data collected and the results found from China can be of great value. We use a mail survey combined with telephone calls to maximize the return rate.

As an exploratory study, the method of simple random sampling is used to collect the data. Since China is a big country, we will strategically choose four cities representing the whole economy of China: Chongqing, Tianjin, Guangzhou, Shanghai, and Hong Kong as our target samples. Chongqing is a traditional industrial base in the northwestern part of China. It is in at a relatively lower stage of economic reform and market formationization. Tianjin is an industrial base in central China and reflects the "average" stage of economic reform and market formation in of China. Guangzhou and Shanghai are in Southern China and have enjoyed a higher degree of economic reform and marketization. We believe these four cities are representative of the general business conditions in China. Therefore, Tianjin, Guanzhou, Chongqing, Shanghai are the representatives of Chinese economic development with comparably market economy, and therefore were selected as sample cities for our study. Hong Kong is a city with a different manufacturing environment from the other cities of China. We choose both Hong Kong and China because we believed that there would be a significant difference on the power and relationship commitment patterns between these two places, since Hong Kong has already been a well developed business structure, which can facilitate sharing a lot better.

Based on previous studies on from relevant supply chain

management literature, the theoretical framework has been proposed and the questionnaire has been designed. The questionnaire included questions on the demographic profile of the company and the questions relating to the company performance, supplier integration, supplier relationship, and supplier use of power. In all these questions, a Likert scale of 1 to 7 was used. In order to ensure the reliability of the questionnaire, the English version of the questionnaire was first developed and then was translated into Chinese by an operations management professor in China. The Chinese version was then translated back into English by another operations management professor in Hong Kong. This translated English version was then checked against the original English version for question accuracy. In Mainland China, we used the Chinese version of the questionnaire. In Hong Kong, we will use the bilingual version of the questionnaire.

Before we launch the full-scale study, we piloted test the questionnaire using a sample of 15 companies. We revised the questionnaire based on the results of the pilot-test and also decide whether to use a single or multiple informants per company.

Moreover, to get a representative sample of manufacturing companies in these four Mainland China cities, we used the yellow pages of China Telecom in each one of the four cities in Mainland China and Directory of the Chinese Manufacturers Association in Hong Kong as a large sampling pool. We randomly selected some of these companies on the lists to contact with telephone calls. These companies come from a wide variety of industries, such as Food, Beverage, Alcohol & Cigarettes, Chemicals & Petrochemicals, Wood & Furniture, Pharmaceutical & Medicals, Building Materials, Rubber & Plastics, Metal, Mechanical & Engineering, Electronics & Electrical, Textiles & Apparel, Toys, Jewelry, Arts and Crafts, and Publishing and Printing.

One importance important challenge for this research is how to collect reliable data concerning the relationship management and process integration with the supplier and suppliers within the supply chain. After visiting over ten companies, we believe that the best way is to get one key informant who is knowledgeable of about supply chain management within the manufacturing companies. This person is normally knowledgeable about the internal processes, processes for purchasing and distributions, and for supplier relationship management, such as supply chain managers, CEO/presidents, senior/executive, vice presidents, senior/executive directors, directors/managers in the companies. Many studies have used a single informant in studying relationship and trust issues between different organizations [42]. However, some researchers have demonstrated the benefits of using multiple informants [13]. We made telephone calls to these companies to identify the manufacturers, make sure that their addresses were correct and also identified the name and contact information for the most suitable informants who were in charge of supply chain management, purchasing and marketing/sales the operations

function. Then we sent the questionnaire to these key informants. A cover letter highlighted the objectives of the survey and its potential contributions to the respondents.

Respondents were encouraged to participate in the survey with an entitlement to a summary report of the results and a small participation incentive. Self-addressed and stamped envelopes were also included together with the survey to facilitate the returning of the completed questionnaires. Follow-up telephone calls were made to improve the response rate. Follow-up mailings were also done if companies request to do them after we contact them by the phone. Respondents were contacted to clarify missing data in their responses.

617 usable questionnaires were received from the contacted 4569 companies, so the rate was 13.5%. A total of 1356 questionnaires were sent out and 617 returned questionnaires were usable. Some of the questionnaires were not used because they were not properly filled out or had too many missing values. The usable response rate was 19.7 %.

IV. 2 Company Profile

The respondents represent a large variety of the companies from a variety of industries. More than 25.49% of the companies are from metal, mechanical and engineering, 17.86% of the companies produce textiles or/and apparel, 13.15% of the respondents are electronics and electrical companies. In details, 35.61% of the companies from Hong Kong belong to textiles and apparel, but only 9.27% of Hong Kong respondents are from metal, mechanical and engineering. 35.58% of the companies in Chongqing are from metal, mechanical and engineering industry, but only 3.85% of Chongqing respondents are from textiles and apparel. 42.00% of the respondents in Shanghai are from metal, mechanical and engineering industry. We can see that the backgrounds of the industry emphasis are different among the five cities. Over 32% of the respondents have the annual sales of less than HK\$5 million, and 14.99% of the respondents have the annual sales of more than HK\$100 million. But in Hong Kong, only 9.09% of the respondents have the annual sales of less than HK\$5 million, and 30.68% of the respondents have the annual sales of more than HK\$100 million. 56.31% of the respondents in Tianjin have the annual sales of less than HK\$5 million, and 4.85% of the respondents from Tianjin have the annual sales of more than HK\$100 million. 49.04% of the respondents in Guangzhou have the annual sales of less than HK\$5 million. Many of the companies in Hong Kong have a bigger sales scale than those from Mainland China.

IV. 3 The Structural Equation Modeling Method

In the study, we use structural equation modeling to estimate the causal relationships among the different constructs with linear structural relations (LISREL) program and a sample of 617 companies. Kline & Klammer [51] contended that LISREL examines the relationships of the variables as a unit, rather than piecemeal as in a regression approach. The

assumption of perfectly reliable measures in regression is untenable and easily handled by LISREL.

Structural equation modeling is a confirmatory approach to data analysis requiring the a priori assignment of inter-variable relationships. It tests a hypothesized model statistically to determine the extent the proposed model is consistent with the sample data. The measurement models specify how the latent variables are measured in terms of the indicator variables as well as address the reliability and validity of the indicator variables in measuring the latent variables or hypothetical constructs. The structural equation model provides an assessment of predictive validity, specifies the direct and indirect relations among the latent variables, and describes the amount of explained and unexplained variance in the model [15; 76].

LISREL 8.54 was used to analyze the hypothesized model. A two-step model building approach was used, wherein the measurement models were tested prior to testing the structural model. The rationale behind this two-step approach is discussed in Joreskog & Sorbom, and Anderson & Gerbing [2; 47]. The maximum likelihood estimation method was used which has desirable asymptotic properties (e.g., minimum variance and unbiasedness) and is scale-free. This estimation method assumes multivariate normality of the observed variables. Recent research has shown that the maximum likelihood method can be used for data with minor deviations from normality [71]. As a check of normality, the P-P plots for a number of variables were checked in the sample, and the data appeared approximately normally distributed.

IV. 4 Measurement Items

Perceived supplier non-mediated power and normative relationship commitment to supplier are measured by five items respectively. Perceived supplier mediated power is measured by six items and instrumental relationship commitment to supplier is measured by three items. All the items are adapted from the scale developed by Brown et al [12]. These indicators are measured using a 7-point Likert scale, with “1” for “strongly disagree”, “7” for “strongly agree”.

Supplier integration, supplier integration, and internal integration are measured by eight items respectively. Our supplier integration scale and supplier integration scale were largely derived from seven items of Narasimhan et al [62] which emphasized information sharing and collaboration and was further substantiated from Morash and Clinton (1998). We adapted some of these items and devised new ones to depict this construct in a most appropriate way. Eight items of internal integration which are focus on data integration, information integration as well as process integration were modified from the scales developed by Narasimhan et al [62]. All indicators are measured using a 7-point Likert scale, with “1” for “strongly disagree”, “7” for “strongly agree”.

Supplier’s performance is measured by five items, which were partly derived from the measurements used by

previous studies. These indicators are measured in the 7-point Likert scale, with “1” for “much worse”, “7” for “much better”.

Financial performance is measured by five items, which were partly derived from the measurement items of “firm performance” in Narasimhan et al [62]. These indicators are measured in the 7-point Likert scale, with “1” for “much worse”, “7” for “much better”.

IV. 5 Construct Validity and Reliability Analysis

Since the data for this research was generated using scaled responses, it is necessary to test for reliability. Reliability is an assessment of the degree of consistency between multiple measurements of a variable [40]. The most commonly used measure of reliability is internal consistency. Flynn et al [30] suggested that the most accepted measure of a measure’s internal consistency is Cronbach’s Alpha. Cronbach’s Alpha coefficient is used [66] to measure the internal consistency of the items included in each of the constructs. The generally agreed lower limit for Cronbach’s Alpha is 0.50 to 0.60 in exploratory research [30; 66]. We followed the two-step method used in Narasimhan et al. [61] to test the construct reliability. First, we did an exploratory factor analysis to ensure the unidimensionality of the scales. Second, we used Cronbach’s alpha to assess the reliability of each construct. Table 1 shows the results of principal components factor analysis with varimax rotation. Cronbach Alpha tests were performed on the constructs (Table 2). Based on the coefficient values, the items tested were deemed reliable for this type of exploratory research [66].

A structural equation model is only reliable if its parameter values can be estimated [71]. Sample size affects the ability to correctly estimate parameter values and determine model fit [76]. Anderson et al [2] suggested a minimum sample size of one hundred and fifty. So, 617 samples are sufficient for the model to be tested in this study.

TABLE 1. Results of Factor Analysis

	Si	Smp	Snrc	Fperf	Sperf	Snmp	Sirc
Eigenvalue	10.12	4.09	3.34	2.78	1.68	1.59	1.21
Variance explained	27.34 %	11.05 %	9.02 %	7.50 %	4.55 %	4.30 %	3.28 %
SI5	0.86	0.18	0.11	0.06	0.06	0.02	-0.03
SI6	0.83	0.15	0.13	0.06	0.07	0.05	-0.02
SI4	0.78	0.22	0.11	-0.04	0.01	0.02	-0.04
SI3	0.77	0.24	0.11	0.11	0.03	0.05	-0.07
SI7	0.75	0.07	0.19	0.05	0.13	0.13	0.06
SI8	0.69	0.04	0.16	0.14	0.26	0.04	0.20
SI1	0.66	0.04	-0.01	0.08	0.07	0.21	0.02
SI2	0.61	-0.05	0.04	0.17	0.20	0.17	0.03
SMP5	0.13	0.81	0.02	0.07	0.02	-0.01	0.18
SMP3	0.07	0.80	0.11	-0.04	0.06	0.06	0.14
SMP4	0.16	0.79	0.15	-0.07	0.06	0.14	0.12
SMP1	0.11	0.76	0.17	0.01	0.01	0.12	-0.06
SMP6	0.14	0.72	-0.02	-0.02	-0.14	-0.01	0.16

SMP2	0.13	0.70	0.19	-0.01	0.11	0.17	-0.08
SNRC3	0.15	0.13	0.83	0.01	0.16	0.15	0.07
SNRC4	0.13	0.15	0.81	0.02	0.17	0.13	0.13
SNRC2	0.16	0.17	0.77	0.06	0.13	0.22	0.05
SNRC5	0.13	0.16	0.73	0.02	0.17	0.18	0.19
SNRC1	0.14	0.08	0.73	0.09	0.28	0.21	-0.03
FPERF2	0.07	0.03	0.02	0.88	0.09	0.07	0.02
FPERF4	0.10	0.00	0.05	0.86	0.10	0.08	0.01
FPERF5	0.11	-0.03	0.03	0.83	0.09	0.08	0.06
FPERF3	0.09	-0.01	0.05	0.82	0.08	-0.01	-0.02
FPERF1	0.07	-0.02	0.02	0.81	0.07	0.00	0.00
SPERF3	0.07	-0.05	0.17	0.09	0.85	0.14	0.00
SPERF4	0.07	0.01	0.18	0.09	0.83	0.16	0.02
SPERF1	0.16	0.04	0.18	0.15	0.77	0.09	0.13
SPERF5	0.10	0.01	0.23	0.12	0.76	0.23	0.07
SPERF2	0.33	0.12	0.08	0.07	0.61	0.13	-0.01
SNMP3	0.18	0.06	0.25	0.10	0.21	0.80	0.03
SNMP1	0.16	0.04	0.26	0.11	0.20	0.70	0.14
SNMP2	0.19	0.23	0.33	0.01	0.28	0.61	0.00
SNMP4	0.17	0.40	0.24	0.09	0.14	0.51	-0.04
SNMP5	0.13	0.29	0.17	-0.01	0.30	0.47	0.11
SIRC1	-0.03	0.28	0.13	0.06	0.01	-0.11	0.78
SIRC2	0.11	0.27	0.25	0.01	0.08	0.01	0.75
SIRC3	-0.02	-0.07	-0.01	0.00	0.09	0.31	0.68

TABLE 2. Reliability Analysis

Construct	No. Of questions	Cronbach's Alpha
Financial performance (Fperf)	5	.905
Normative Relationship Commitment to Supplier (Snrc)	5	.900
Instrumental Relationship Commitment to Supplier (Sirc)	3	.694
Perceived Supplier Non-mediated Power (Snmp)	5	.822
Perceived Supplier Mediated Power (Smp)	6	.883
Supplier integration (Si)	8	.904
Supplier's performance (Sperf)	5	.875

The data collected by surveys and other empirical designs is of little use unless its reliability and validity can be demonstrated [30]. O'Leary-Kelly et al [67] mentioned that the methodological issue of construct is generally ignored in most of previous empirical researches in operations management area. There are two dimensions of construct validity: discriminant validity and convergent validity. Discriminant validity is the degree to which measures of different latent variables are unique [67]. Convergent validity relates to the degree to which multiple methods of measuring a variable provide the same results [67]. In our study, we try to assess those two kinds of validity by CFA models in structural equation models. O'Leary-Kelly et al [67] suggested that the confirmatory

factor analysis (CFA) method of assessing convergent and discriminant validity is a more powerful tool and requires fewer assumptions than the traditional MTMM matrix method.

At the beginning, we construct the CFA model using LISREL program. In the model, each item is linked to its corresponding construct and the covariances among those constructs are freely estimated. The model fit indices are Chi-Square = 2379.21 with Degrees of Freedom = 603, RMSEA=0.069, which indicate that the model is acceptable [44]. Generally, a construct with either loadings of indicators of at least 0.5, a significant t-value ($t > 2.0$), or both, is considered to be convergent valid [17; 31]. For our model, most of the factor loadings are greater than 0.50 and the t-values are all greater than 2.0 (Table 1). Therefore, convergent validity is achieved in our study.

In order to assess the discriminant validity, we build a constrained CFA model, in which the correlations among constructs are fixed to 1. This model will be compared with the original unconstrained model, in which the correlations among constructs are freely estimated. A significant difference of the Chi-square statistics between the fixed and unconstrained models indicates high discriminant validity [17; 31]. In our study, the difference of χ^2 is significant at 0.05 significant level. Therefore, the discriminant validity is ensured in our study.

IV. 6 Structural Model and Hypotheses

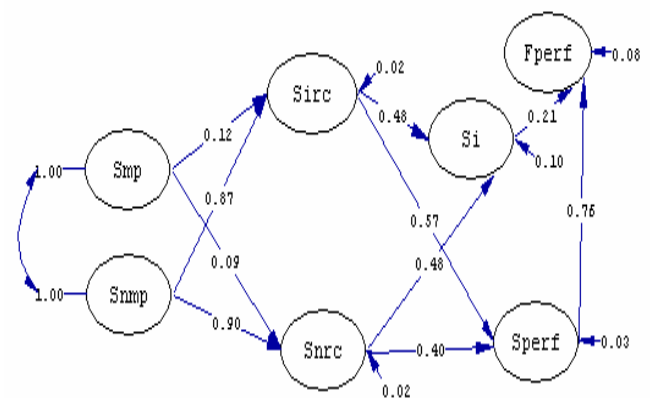


FIGURE 2. Structural Equation Model

The structural model was analyzed based on the modified measurement models using the maximum likelihood estimation method. Figure 2 shows the modified structural equation model and standardized coefficients. All coefficients shown were significant at 0.05 levels except for H9. The initial model as shown in Figure 1 was tested, resulting in ten significant path coefficients (H1-H8, and H10-H11), suggesting the support in the data for the relationships. The data supported hypotheses H1- H8, H10-H11, namely, that companies with a greater level of mediated power with suppliers are more likely to have a

stronger normative relationship commitment and instrumental relationship commitment with suppliers. Companies with a greater level of non-mediated power with suppliers are more likely to have to a stronger normative and instrumental relationship commitment with suppliers. Companies with a stronger normative or instrumental relationship commitment with suppliers are more likely to have to a greater extent of supplier integration. Companies with a stronger normative or instrumental relationship commitment with suppliers are more likely to have to a greater extent of supplier's performance. Companies with a greater extent of SC performance are more likely to have a greater extent of financial performance. H9 is not supported by the data. That means that supplier integration has no significant influence on supplier's performance.

In structural equation modeling, there is no single test of significance that can absolutely identify a correct model given the sample data [76]. Much goodness of fit criteria has been established to assess an acceptable model fit. Consequently, several authors recommend presenting a number of indices to support model fit [5; 35]. This paper presents and discusses a number of fit indices with the results. The goodness of fitness indices for our model are $\chi^2(612) = 2631.78$, NFI = 0.99, NNFI = 0.99, CFI = 0.99, RMSEA = 0.073, Standardized RMR = 0.016. These indices are better than the threshold values suggested by Hu et al [44]. In particular, Cheung & Rensvold [20] argued that the more complex models should be evaluated using lower cutoff values and the simpler models should be evaluated using higher cutoff values. Therefore, our model can be accepted for future discussion.

V. Discussion

V.1 Supplier Integration and Performance

Supplier integration significantly impacts financial performance of the manufacturers. Manufacturers' supplier's performance has a positive influence on financial performance of the manufacturers. Supplier integration has no significant influence on supplier's performance. That may be for that we selected the data sample pool from the manufacturers in Mainland China and Hong Kong. For the manufacturers we surveyed, they paid more attention to the customers because that usually they have more problems for marketing. In order to sell their products; they integrated the customers with their internal operation process according to the "customer focus" operation strategy. But for suppliers, the manufacturers are their buyers or customers. The supplier usually were ignored or emphasized by the manufacturers. So the extent of supplier integration is not so high as to have a significant influence on supplier's performance of the manufacture.

The relationship between supply chain supplier integration and performance has been discussed over a vast body of supply chain and operations literature. For example,

Stank et al [78] developed and tested an instrument for measuring supply chain integration competences as well as determining their relative importance to developing logistics distinctiveness. Supplier and internal integration are considered the most important differentiators of overall firm performance. Stank et al [79] suggested that collaboration with supply chain partners facilitates internal collaboration, which in turn enhances logistics performance. Besides, Frohlich et al. [33] demonstrated that supply chain companies with the widest degree of the arcs of integration achieve the highest level of performance improvement involving the supplier service, on-time delivery, delivery lead time, productivity, quality, and cost, in addition to the market share and profitability. Most previous researchers only tested the association between integration and supply chain performance, while in practicality, business executives will primarily concern about the financial performance. The last supported hypothesis grasps the true relationships between supply chain performance and financial performance.

V. 2 Relationship Commitment and Supply Chain Supplier Integration

Both manufacturers' normative and instrumental relationship commitment to suppliers significantly impact supply chain supplier integration and supplier's performance. That means that companies with a stronger relationship commitment to suppliers are more likely to have to a greater extent of supplier integration and achieve the better supplier's performance. We can see that manufacturers' normative relationship commitment to suppliers has the same influence on supplier integration as manufacturers' instrumental relationship commitment to suppliers does (both the standardized coefficients are 0.48). And manufacturers' instrumental relationship commitment to suppliers has a higher influence on supplier's performance (standardized coefficient: 0.57) than manufacturers' normative relationship commitment to suppliers does (standardized coefficient: 0.40). From the relationship of supplier integration and supplier's performance and financial performance we discussed in last section, we know that manufacturers' instrumental relationship commitment to suppliers also has a higher influence on manufacturers financial performance than manufacturers' normative relationship commitment to suppliers does. The manufacturers should commit more instrumental relationship to the suppliers to pursue the high performance. From the relationship between relationship commitment and supplier integration, we can find one of the important drivers for supply chain integration.

Based on the high and good relationship commitment, the suppliers are very likely to cooperate with the partners in the same supply chain. The results of this study are agreed with the results of the previous studies. Prahalinski et al [70] developed and empirically tested a model that explained how suppliers perceive the buying firm's supplier evaluation communication process and its impact on suppliers' performance. The results indicated that buyer-seller

relationship influences supplier commitment, which eventually yields better supplier's performance. Unless the supplier is committed to the buying firm, the supplier evaluation communication process doesn't ensure better supplier's performance. Furthermore, it has been suggested that the buying firms should increase their efforts on cooperation and commitment in order to augment the supplier's commitment.

Today, the competition is not amongst the companies, but amongst the supply chains. Supply chain supplier integration is getting more and more attention from both the academicians and the practitioners. Based on a high relationship commitment, the suppliers are more likely to cooperate with the manufacturers. So the manufacturer will have less difficulty to integrate the suppliers with its own operation process in the supply chain to achieve the competitive advantages. Many previous papers failed to find out the impacts of relationship commitment on the supply chain supplier integration.

V.3 Power and Relationship Commitment

Power has the positive influence on relationship commitment. That means that the suppliers' use of both mediated and non-mediated power have the positive impact on both normative and instrumental manufacturers' relationship commitment to the suppliers. Supply chain organizations must evaluate their supply chain partners by different perspectives and develop an appropriate level of power in response to perceived risks in different scenarios. Based on power, commitment is formed to extend the relationships. Power as a business decision must precede the committed investment. This conclusion has also been tested by some other researchers. Brown et al [12] found that the supplier's use of different power may bring different retailer's commitment to the channel relationship. Goodman et al [37] argued power was becoming one of the important determinants of relationship commitment in the distributor-manufacturer relationship.

From the results of the model, we can also find that, the influence of suppliers' use of mediated power on manufacturers' instrumental relationship commitment to suppliers (standardized coefficient: 0.12) is nearly equal to the influence of suppliers' use of mediated power on manufacturers' normative relationship commitment to suppliers (standardized coefficient: 0.09). The influence of suppliers' use of non-mediated power on manufacturers' instrumental relationship commitment to suppliers (standardized coefficient: 0.87) is nearly equal to the influence of suppliers' use of non-mediated power on manufacturers' normative relationship commitment to suppliers (standardized coefficient: 0.90). The suppliers' use of non-mediated power has a much higher impact on manufacturers' normative relationship commitment to suppliers (standardized coefficient: 0.87) than suppliers' use of mediated power does (standardized coefficient: 0.12). The suppliers' use of non-mediated power has a much lower impact on manufacturers' normative relationship

commitment to suppliers (standardized coefficient: 0.09) than customers' use of mediated power does (standardized coefficient: 0.90). Non-mediated power has a much higher influence on relationship commitment than mediated power does. From the analysis of last section, we also know that non-mediated power is more powerful to increase the supplier integration. The suppliers' use of more non-mediated power is better for the manufacturers' supplier's performance and financial performance.

The suppliers' use of mediated power can positively and significantly influence both manufacturers' instrumental and normative relationship commitment to suppliers. But the suppliers' use of non-mediated power has little impact on manufacturers' relationship commitment to suppliers. For relationship commitment, manufacturer's instrumental and normative relationship commitment to the supplier has the equal impact. But manufacturer's instrumental relationship commitment has a higher influence on supplier's performance than manufacturers' normative relationship commitment does. That means that, in China, the suppliers have a relative lower power on manufacturers than the power used by the manufacturers on the suppliers.

VI. Conclusions

This study firstly examined the relationships between power, relationship commitment, supply chain supplier integration and manufacturers' performance in the context of a holistic model that allowed for the simultaneous testing of these relationships based on the data from Mainland China and Hong Kong. With the growing awareness of power, relationship commitment and supply chain integration over the past decade, it is an important issue to improve the understanding of these variables and the associated relationships. Our research contributes to the supply chain management literature by proposing and empirically testing a supply chain supplier integration model. The model illustrates the effect of power, relationship commitments on supplier integration within the supply chain and manufacturers' performance. This model can be used as a basis for further empirical work in supply chain management. Moreover, the knowledge of this model should provide some guidelines for managers as to how to direct their improvement efforts to achieve superior manufacturer's performance. In addition to the grounded theoretical benefits of applying our recommended practices, empirical validation enables the managers to adopt the most effective practices of supply chain management for enhancing their competitiveness in today's highly competitive global market place.

In conclusion, our study identified the factors of the supply chain supplier integration and the relationship between the factors and supplier integration. It investigated the relationship between two types of power and two types of relationship commitment and found that both types of power have the positive influence on supply chain supplier integration. Our model also revealed that manufacture

performance is dependent on the extent of the supply chain supplier integration.

There are some limitations in the power, relationship commitment and supply chain supplier integration model. The relationships between the two types of power are not explained. Environmental factors that can have a differential influence on supply chain supplier integration and relationship commitment are not included. Such as that trust is regarded as one important factor impacts relationship commitment by many researches. There should be a classification of the companies from Mainland China and Hong Kong though they share the same Chinese culture and industry background.

The future research directions can be stimulated from the limitations of this research, i.e. the initiators of the supply chain supplier integration demand further research. The relationships between two types of power and between two types of relationship commitment should be identified. Other factors that impact power and relationship commitment should also be tested. Future studies could also focus on a better understanding of the differences between high and low performers from Mainland China and Hong Kong, and the process that can enable a low performer to become a high performer. The similar research about power, relationship commitment, customer integration and manufacture performance can be conducted.

VII. Appendix

VII.1 Construct Measurement

Financial performance (Fperf)

FPERF1: Growth in sales

FPERF2: Growth in profit

FPERF3: Growth in market share

FPERF4: Growth in ROI

FPERF5: Growth in return on sales

Normative Relationship Commitment to Supplier (Snrc)

SNRC1: We feel that our major supplier views us as being an important "team member," rather than our being just another customer

SNRC2: We are proud to tell others that we are a customer of this supplier

SNRC3: Our attachment to this supplier is primarily based on the similarity of our values and those of this supplier

SNRC4: During the past year, our company's values and those of the major supplier have become more similar

SNRC5: What this supplier stands for is important to our company

Instrumental Relationship Commitment to Supplier (Sirc)

SIRC1: Unless we are rewarded for it in some way, we see no reason to expend extra effort on behalf of this supplier

SIRC2: How hard we work for this major supplier is directly linked to how much we are rewarded

SIRC3: Bargaining is necessary in order to obtain favorable terms of trade with dealing with this supplier

Perceived Supplier Non-mediated Power (Snpmp)

SNMP1: The people in the supplier's organization knew what they are doing

SNMP2: We usually got good advice from our major supplier

SNMP3: The supplier had specially trained people who really knew what had to be done

SNMP4: We really admire the way our major supplier runs their business, so we tried to follow their lead

SNMP5: Our major supplier's business expertise made them likely to suggest the proper thing to do.

Perceived Supplier Mediated Power (Smp)

SMP1: We had an obligation to do what the major supplier wanted, even though it wasn't a part of the contract

SMP2: Since they were the supplier, we accepted their recommendations

SMP3: We felt that by going along with the major supplier, we would have been favored on some other occasions

SMP4: By going along with the major supplier's requests, we avoided some of the problems other companies face

SMP

5: Our major supplier often rewarded us to get our company to go along with their wishes

SMP

6: The major supplier often hinted that they would take certain actions that would reduce our profits if we did not go along with their requests

Supplier integration (Si)

SI1: The level of information exchange with our major supplier through information network

SI2: The establishment of quick ordering system with our major supplier

SI3: The participation level of our major supplier in the process of procurement and production

SI4: The participation level of our major supplier in the design stage

SI5: Our major supplier shares their Production Schedule with us

SI6: We share our production plan with our major supplier

SI7: We share our demand forecast with our major supplier

SI8: We help our major supplier to improve their process to better meet our needs

Supplier's performance (Sperf)

SPERF1: Our major supplier can quickly modify products to meet our company's requirements

SPERF2: Our major supplier can quickly introduce new products into the markets

SPERF3: Our supplier has an outstanding on-time delivery record to our company

SPERF4: The supplier's lead time for fulfilling our company's orders (the time which elapses between the receipt of our order and the delivery of the goods) is short

SPERF5: Our major supplier provide high level of customer service to our company

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Enhancing On-Site Maintenance Execution with ICT

– A Case Study

Olli Lehtonen*, Timo Ala-Risku **

Department of Industrial Engineering and Management,
Helsinki University of Technology, Helsinki, Finland

P.O.Box 5500, FI-02015 HUT, Finland

fax +358 9 451 3665

* olli.lehtonen@hut.fi, +358 50 371 4110

** timo.ala-risku@hut.fi, +358 40 544 9211

Abstract: Information and communications technologies (ICT) can be used to improve the efficiency of field service processes. The role of ICT in assisting the planning process of preventive equipment maintenance has been abundantly discussed in the literature, but the actual on-site maintenance execution and the value of information have escaped the attention of most researchers. This gap in research has been pointed out by a few authors [4][25]. Due to the scarce literature on ICT support for maintenance operation execution, we pose the following research problem: How can maintenance execution be helped with better information? This problem is approached by examining how the unavailability of information does affect maintenance execution performance, and what the most often required pieces of information are.

This study includes a literature part and a case study. In the literature part, we first examine the maintenance environment where breakdown maintenance policy and field service are distinguished as the most challenging environments in terms of managing equipment down-time. After that, we examine equipment down-time and uses of ICT systems in accordance with a framework for the components of defect rectification time that is built upon a model according to Knotts [21]. In the case study, we examine the service company network of a Finnish capital goods manufacturer. We use interviews, survey of service companies, and data analyses to examine the case in accordance with the framework developed in the literature part.

The study revealed that about 40% of the failed service visits are caused by the unavailability of information. In addition, almost a third of the service visit's duration is used to inquire for equipment details and to diagnose the problem. We conclude that better information would increase the service call success ratio and would cut down the duration of the on-site service operations.

Keywords: SCM & E-logistics; Case study in E-business.

I. Introduction

The benefits of information and communications technologies (ICT) in maintenance services are widely recognized. As early as in 1988 Ives and Vitale claimed that ICT could be a significant factor in leveraging investments in maintenance and in directing a company's overall approach to the maintenance issue. More recently, Agnihothri et al. [4] among others have pointed out the usefulness of ICT in maintenance. In the literature of ICT facilitated maintenance, the focus seems to be on the sophisticated maintenance solutions, such as condition-based maintenance [18][34], problem diagnosing tools [18][28] and life-cycle information acquisition [25][30][31]. While the value of these sophisticated systems must not be understated, we find it surprising that the information needs in performing the actual service operations are scarcely addressed in the literature. Marsh and Finch [25] have pointed out the same issue by claiming that there still are problems in providing the basic product information for the service personnel. We argue that this is a notable deficiency since the on-site operations are the most critical element in providing effective field-service. Whether the service call is triggered by the decreased condition of the equipment, a maintenance schedule or an equipment breakdown, it always comes down to fixing the problem on-site. Moreover, the on-site operations are the most visible element of field-services for the customers.

Based on a survey of field-service companies in an industry of electrical investment goods, we present effects that information availability has on field-service execution in terms of service call accomplishment ratio and on-site time usage. Our research problem is how maintenance execution can be helped with better information. The paper is structured as follows. In the first part, we discuss relevant maintenance literature addressing maintenance policies, equipment down-time and information needs in maintenance operations. In the second section, we give the research design of this study. The third part presents the results of the study, followed by discussion and further research suggestions.

II. Literature Review

First, we give background and motivation for studying and developing maintenance operations. We do this by analyzing maintenance policies and presenting the restrictions in their

applicability. In the second section we exhibit a framework for analyzing service operations in terms of process steps and the possibilities of influencing the steps with better information availability. In addition, reported ICT tools for maintenance operations are reviewed in light of the framework.

II. I Maintenance Environment

The primary objective of equipment maintenance is to preserve system functions in a cost-effective manner [34]. Under this general goal, different parties have their own objectives for maintenance and that is why maintenance performance should be measured from several viewpoints. Consequently, maintenance performance measures can be divided into three common categories [33]: equipment performance, cost performance, and process performance. From the equipment user's viewpoint, the most important goal of maintenance is to minimize the down-time of equipment. This is the equipment performance standpoint. For a manager of a maintenance organization, the interests are also in maintenance costs and efficient execution of the maintenance process. These represent cost performance and process performance standpoints. In this paper, the focus is on maintenance process performance since it delineates the maintenance execution performance. In addition, improving process performance typically enhances also cost performance and equipment performance and is therefore a very important measure for a field-service organization.

The objectives of maintenance can be pursued using different maintenance policies which all aim at reducing the equipment down-time. These policies can roughly be divided in corrective maintenance and preventive maintenance. In the former case, maintenance operations are carried out after an equipment failure has been identified, while in the latter group the goal of operations is to replace equipment or return it to good condition before failure occurs [15][34].

Preventive maintenance methods are further divided to scheduled maintenance methods and condition-based maintenance methods [36]. Scheduled maintenance is achieved when maintenance tasks are performed following a time or usage based schedule. Optimal schedules can be determined using quantitative decision models, but usually they are only drawn up on the supplier's recommendations on mean failure times [15][34].

Condition-based maintenance (CBM) is a more sophisticated type of preventive maintenance. The condition of the item is monitored continuously or intermittently to carry out preventive maintenance actions only when failure is judged to be imminent. Thus, replacing or servicing equipment prematurely can be avoided. Decision when the maintenance task is carried out is made based on the condition monitoring techniques, as vibration monitoring, process-parameter monitoring, thermography, and tribology [34].

However, despite that the preventive maintenance policies are designed to reduce the number of equipment

breakdowns and reduce the uncertainty of down-time by planning in advance, equipment breakdowns cannot be totally eliminated.

First, there are trade-offs between the costs of scheduled maintenance or condition monitoring and the costs of a breakdown. The aim of maintenance policy selection is to find the most cost-effective strategy [24][34]. When striving for optimal maintenance costs, different parts of a production facility most likely require different maintenance policies [36], thus potentially leaving some equipment to be serviced only in cases of breakdown.

Second, breakdowns cannot wholly be eliminated with preventive maintenance measures. Scheduled maintenance is often based on either measured or supplier specified equipment mean-time-between-failures, but in reality the failures take place at random times, and therefore breakdowns will at times happen between scheduled maintenance actions [27]. Also, with condition-based maintenance it is to be noted that no inspection or monitoring can be 100% effective, as the condition needs to be identified correctly, and the symptoms of a failure are not always noticed [13]. Further, the opportunity window between the emergence of abnormalities and consequent failure may be too short for the symptoms to be recorded in an inspection or monitoring process [27].

Third, the implementation of sophisticated maintenance strategies can be difficult in companies with established maintenance traditions. A study of four manufacturing firms in the UK indicated that in practice many advanced maintenance philosophies are not adopted fully in organizations, as the service technicians may remain unfamiliar with the concepts. As a result, planned maintenance activities give way to short-term needs of keeping the plant running, which results in firefighting activities and breakdown maintenance [12]. Thus, corrective maintenance in the form of breakdown repairs is not always a deliberate choice, but rather results from ignorance towards maintenance planning [16].

As we presented, equipment breakdowns cannot be totally eliminated. What makes this notion important is that down-time is especially problematic for equipment that relies on corrective maintenance or otherwise breaks down. First, such equipment easily experiences a longer down-time than equipment with preventive maintenance, which is demonstrated in the following section. Second, the resulting unplanned down-time of equipment is far more costly than planned stoppages due to loss of committed production, decrease in quality, and inefficient use of facilities, equipment and personnel [7]. Examples of down-time costs per hour have been quoted as 1.000 EUR in the energy industry to 13.000 EUR in the chemical industry [24]. Due to these reasons, reducing down-time for equipment breakdowns is especially important.

Before examining the components of down-time in detail, we present the concepts of field-based and facility-based maintenance that also have an impact on the down-time components. In field-based maintenance i.e. field-service, it

is the responsibility of the service provider to perform maintenance operations to the equipment located at a customer's site [4]. The opposite approach is facility-based service, where customers access the service facility [4]. In this study, we focus on one sub-category of field-service that is after-sales service support. Agnihothri et al. [4] point out that after-sales service support is the most problematic in terms of down-time. For companies engaged in after-sales service support, it is important that they manage both service response time, i.e. time it takes to access the service site, and on-site time, i.e. time it takes to carry out the on-site operations.

To summarize the main findings, it seems that in terms of maintenance policy, it is corrective maintenance that poses the greatest challenges for managing equipment down-time. In addition, the most challenging type of field-based maintenance, in terms of down-time, is after-sales service support. The case study presented in this paper comes from an environment where both of these challenges are realized, and therefore it provides a good research platform to study this phenomenon.

II.2 Equipment Down-Time and Uses of ICT Systems

According to Knotts [21], the time it takes to rectify a defect consists of four main phases: identification that a problem exists, gaining access to the equipment, diagnosing the problem and locating the cause, and taking necessary corrective action. Knotts argues that there are differences in the predictability for the durations of the different steps of defect rectification time. He explains that time covering access, defect rectification, and test and close up can be forecasted based on either experience or predictive techniques using time standards. On the contrary, the problem identification and fault diagnosing times are difficult to predict. Knotts argues that the unpredictability arises from non-standardized procedures and lack of time prediction techniques covering fault diagnosis and isolation. His presentation of down-time is especially useful, when evaluating the impact of different ICT systems on the maintenance execution process.

The context where Knotts applied his framework was that of facility-based maintenance [21], where it is possible to warehouse scores of spare-parts as back-up and have a variety of tools and documentation available at the service facility. This is not possible in field-based service, which makes it necessary to prepare in advance for the operations [8]. Consequently, we add an additional step "preparation" and a possible return loop that results from failure to deal with the defect (Figure 1). The importance of this addition is highlighted by statements that the probably most typical problem in field-service is not having the correct spare-part available on site [26]. For comparative purposes between maintenance policies, we also distinguish between three different initial stages for the defect rectifying process (Figure 1). Next, the information needs and utilization of ICT in different phases of the maintenance process is examined through a review of reported ICT systems. In

general, it seems that the ICT solutions in field-service have not been the focus research area of academics. Nevertheless there are reports of maintenance support systems used in various field-service organizations published mainly in non-academic trade journals. This literature review aims at enlightening the different kinds of maintenance support tools that are adopted in field-service, but it is not intended to be inclusive. Appendix 1 summarizes the example cases of ICT tools used in the field-service execution.

II.3 Problem Identification

The uncertainty for the duration of the first phase, problem identification, relates to the need of timely and correct information that the equipment is performing at an unacceptable level. For equipment run under breakdown maintenance policy, the problems are identified after the failure has occurred and the down-time timer has started ticking. This does not hold true in preventive maintenance where the problem identification is carried out using non-intrusive techniques while the equipment is operational or during planned stoppages, thus the time required for identification does not result in additional and unexpected downtime for the equipment.

The most typical ICT tools in the failure reporting and confirmation phases are condition monitoring tools. These facilitate automatic identification of the occurring and upcoming problems and thus reduce the uncertainty related to the prediction of the duration of these phases. The earliest case-reports come from the 1980's and the reported utilization cases of condition monitoring and CBM have become more frequent since. Today, condition-based maintenance encompasses several techniques and it is used in various industries including automobile manufacturing [3], power industry [2][23], aircraft engine maintenance [22], and ship engine maintenance [19]. There is some variation in the terminology of the CBM systems, for example term *Built-in-test-equipment* (BITE) is commonly used in the aircraft industry [20], but the operating principles are the same.

II.4 Preparation

The preparation step is critical for successful accomplishment of a service call, especially in field-based service. The objective of this phase is to ensure that the correct maintenance resources, the required documents and spare-parts, and the subject of maintenance operations i.e. the equipment will all be available during the service visit. Inadequate preparation may denote that the service technician is unable to rectify the defect, which leads to a failed service visit and a need for a follow-up visit, indicated as the return loop in Figure 1. In facility-based maintenance [4], the role of the preparation phase is less important, since the maintenance resources, documents, spare-parts, and subject of maintenance are all located in the service facility. If a service call cannot be accomplished in facility-based maintenance the servicing is postponed but there is no need for additional preparation and access gaining phases.

The effectiveness of the preparation phase depends strongly on the advance information available on the identity of the equipment and the type of failure. Identifying the

will the most likely be needed during the service visit [18], and thus reducing the number of return visits and increases field-service function's efficiency. One example of

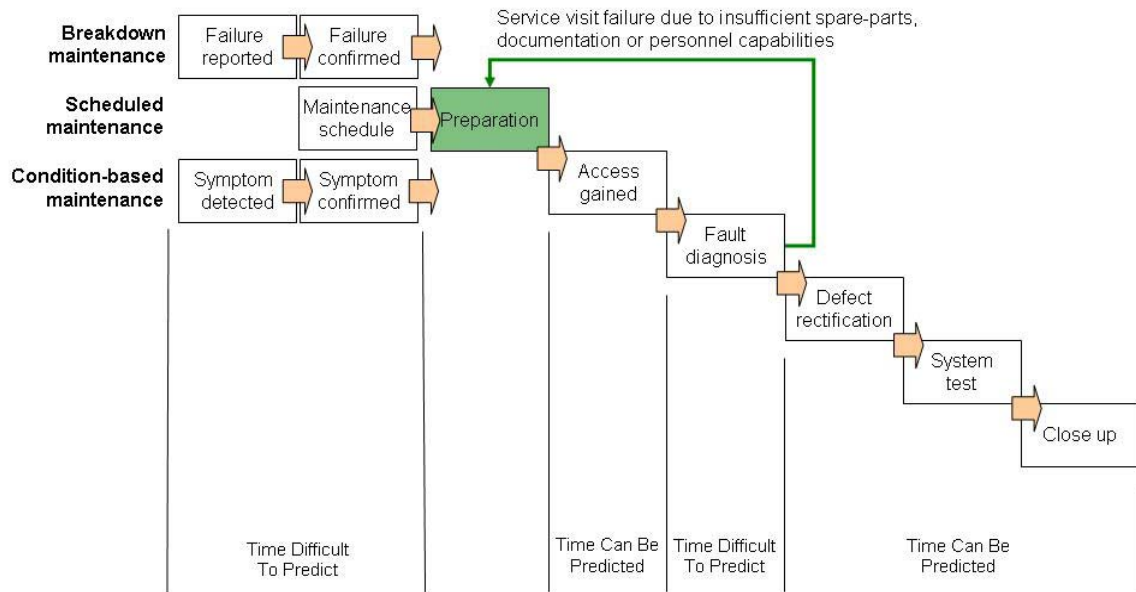


FIGURE 1 COMPONENTS OF DEFECT RECTIFICATION TIME (APPLIED FROM KNOTTS, 1999)

equipment based on e.g. its model or serial number allows the selection of the right kind of maintenance resources, spare-parts, and documentation for a service call. Advance information on the failure type may make this more efficient if the possible problem can be hypothesized.

The amount and quality of advance information varies among the maintenance policies. In breakdown maintenance the available information is most uncertain: the identity of the equipment and description of the failure rest on the expertise of the person reporting the failure. With scheduled maintenance, the service technician knows the identity of the equipment, but there is no information available on the equipment condition. However, in scheduled maintenance there typically are predefined periodic maintenance tasks that are to be carried out. For example, in case of elevator maintenance, the periodic maintenance tasks may include adjusting equipment, examining and repairing or replacing worn components, and lubricating parts and cleaning certain areas [9]. The periodic maintenance operations can be used to determine the necessary tools and the spare-parts most likely needed. In principle, the situation is best when using condition-based maintenance where the equipment identity and symptoms are known in advance and thus the failure type can be hypothesized.

Besides the condition-monitoring devices listed above, the ICT tools designed for the preparation phase assist in ensuring that the correct maintenance resources, the required documents and spare-parts, and the subject of maintenance operations will all be available during the service call. Xerox has been reported to use a system telling which spare-parts

preparation in facility-based maintenance is a system that determines spare-part needs for a damaged ship-engine, identifies the nearest repair facility, and guides the ship crew to prepare the engine for the repair [18]. Preparation can also be done for the follow-up service visit if such is needed. For example, Sears Roebuck & Co. is using a wireless support system to order a spare-part and schedule a second visit for the service technician to install the part [6]. This kind of system provides assistance when it is not possible to predict the spare-part needs before the service technician analyses the problem on-site.

II. 5 Gaining access

The next step in the defect rectification classification is gaining access to the equipment, which in field-based service is carried out so that the service technician moves to the equipment. In this phase, the service technician needs to know where, when and how the equipment should be accessed. In principle, the selected maintenance policy does not affect the access gaining phase. Instead, service response times are typically determined in maintenance contracts and service-level agreements (SLA) [35].

The ICT solutions available for the access gaining phase are related to routing the service resources. The most modest systems provide service technicians with information on available service calls [14]. In order to gain scale benefits, the systems can be used to route the field-service workforce more efficiently to complete more service calls a day. Several example cases can be found for using wireless field-service support systems for routing and service call

management [6][9][32]. The factors considered in assigning routes can be geographic proximity, technician workload, necessary skills, and customer relations [9]. One significant benefit of these systems is that the service technicians can acquire new job orders online, without returning to the workshop, which increases service responsiveness and efficiency. Because a routing system can take into account the skills of the workforce, they may also assist in correct preparation.

II.6 Diagnosis

The fault diagnosis phase aims to identify the problem and determine the required corrective actions. It is an information intensive phase, where maintenance technicians traditionally rely on technical publications for information covering fault diagnosis procedures, configuration details, and functionality descriptions [21].

There are some reports on ICT tools used in the fault diagnosing & isolation phase, which aim at aiding the service technicians to locate the problem quickly and properly. Automatic failure diagnosing tools take symptoms and some other parameters as input information, and based on a knowledge base, suggest what the probable failure reason is [18]. In addition, there are tools to provide the service technicians with information that might help in their decision making [25][37]. The pieces of information that seem to be valuable in the fault diagnosing & isolation phase are service history for the serviced equipment, service call reports for similar cases, and schematics [6][25][37].

II.7 Failure loop

The fault diagnosis phase continues with defect rectification step. However, it might turn out that – for a reason or another – the service technician is unable to rectify the defect and has to return with the proper utensils to access the equipment again (indicated as the return loop in Figure 1). This increases the need for accurate information for service personnel to ensure they have all the necessary documentation, tools and parts with them for the first time. It is especially critical in breakdown maintenance, where the down-time continues if the first service visit fails. In addition, an unaccomplished service visit decreases customer satisfaction, and a follow-up visit to the facility decreases operational efficiency of the maintenance personnel. It comes as no surprise that reducing the requirement for repeat or follow-up service calls has been commented to be one of the largest cost-saving opportunities for companies engaged in field-service [10].

II.8 Rectification and reporting

The final steps are defect rectification, system testing and close up. These steps include adjusting, repairing or replacing equipment and ensuring that the resulting configuration is operating as it should. Finally, the required documentation, e.g. service report and invoice, is produced. [21]

The supporting ICT tools include means for accessing

technical documentation in electronic form and for generating service reports and invoices. The productivity improvements in defect rectification from having technical information available via a wireless computer compared to paper-based systems may be significant, since all the information can be accessible through one interface. In the case of SkyWest Airlines Inc. [29], this time saving was anticipated to be as much as 1.5 hours a day for one service technician. The role of accurate information in defect rectification is emphasized by the fact that there are reports on maintenance induced failures, where subsequent equipment failures have been pinned down to be caused by mistakes of service technicians due to lack of information on correct procedures and parts [13].

Finally, during the system testing and close up phases, the most important tasks for the service technician are to make sure the equipment is in order, and to invoice the customer. Automatic diagnosing systems and condition monitoring tools may help the service technician in the system testing phase, but there seems to be no case examples in that area. However, automatic test equipment have been reported to reduce test times by more than 60% in factory production environment [17], so evidence for increasing testing efficiency with ICT tools exists.

In field-service context, there exist reports on ICT tools for creating and managing service reports and invoices. Brown [10] and Albright [5] stress that by using wireless computers to create the service reports on-site it is possible to reduce the amount of paperwork and improve data accuracy. In addition, one significant benefit of making the invoice on the site is that the payment cycle starts immediately.

As a conclusion from the down-time examination, the down-time of equipment is likely to be the longest with breakdown maintenance, and the information for identification and rectification the scarcest. While condition-based maintenance is designed to inherently provide the best information to carry out maintenance operations effectively and efficiently, there is no reason why information availability should not be secured for less sophisticated maintenance approaches, especially as shown, it is not possible to completely avoid breakdowns.

Summarizing the ICT review, there clearly seems to be indications that ICT can provide great assistance to the different phases of field-service execution. The exemplary ICT use cases are summarized in Appendix 1. Unfortunately, it seems that the support that ICT might give to the effectiveness of field-service operations has been scarcely studied [4]. Especially the magnitudes of the impact or the types of information making the impact have not been evaluated. Understanding the potential implications and sources of impact is especially important in the evaluation of the feasibility of different ICT systems, and therefore we address this as a notable gap in the literature.

III. Research design

Despite the reported ICT solutions, the implications of information availability in maintenance have not been addressed in such a level that it would be possible to assess the benefits of implementing ICT solutions. Therefore we pose the following research problem: How can maintenance execution be helped with better information? To approach this problem, we seek for answers for the following research questions:

How does the unavailability of information in field-service affect maintenance execution performance?

What are the most critical pieces of information required in different process phases?

The purpose of the first research question is to determine how big performance efficiency losses the unavailability or incorrectness of information may incur. The efficiency losses will be quantified in terms of service call accomplishment ratio and service visit time usage. With service call accomplishment ratio we mean the share of service calls that are accomplished during the first service visits. The second research question seeks to define the unavailability of which particular pieces of information is causing the problems. That way it is possible to give recommendations on how the information availability could be improved.

As was discussed before, breakdown maintenances and field-based maintenance service form a challenging environment where the requirements for information to manage and reduce down-time are high. On the other hand, such an environment provides a good research platform to study how maintenance execution can be helped with better information, and thus our study was conducted with a manufacturer whose service company network is operating in such a challenging environment.

The focal case company of the study is a capital goods manufacturer. Its customer base includes hundreds of companies of various sizes who utilize the case company's products in their own operations. In practice, the equipment manufactured by the case company are located in customer sites scattered to various locations.

IV. Research Methods

The study included interviews, a survey, and database analyses. The case setting was first studied in detail with initial interviews including 14 interviewees at the focal company, 3 interviews with service companies, and 2 interviews with customers of the focal company. Most of the interviews were performed with two researchers to guard for interviewer bias by allowing comparisons of interview notes and perceptions. After agreeing on all interview items, the interview memorandums were stored in a case study database for easy later access.

To answer the research questions, we performed an industry-wide survey of maintenance companies. The initial interviews with representatives from the manufacturer, maintenance companies, and customer organizations were used as input while designing the survey questionnaire. The

survey was targeted to the service company network of the focal capital goods manufacturer including 56 service companies with a geographical coverage of the entire Finland.

The questionnaire used in the survey consisted of open-ended questions and multiple choice questions which were used to collect both qualitative and quantitative data. The questionnaire had two main parts. The first part concentrated on the service operations and the implications of poor availability of information. The second part aimed to solve what information would be needed for better operations. Before launching the survey, the questionnaire was tested with three service companies whose feedback was used to reform the questionnaire. Each company was contacted by phone beforehand and the questionnaire was delivered by mail, e-mail, or fax, based on each the respondent's preference. All non-respondents were contacted again after the initial deadline for returning the questionnaire. The response rate turned up to be 55% with 31 responses, and the respondents were mainly service managers and company owners.

The respondent companies diverge, to some extent, in terms of their scope of servicing activities and the company specialization. The respondents are mostly small companies with only a few service technicians; 75% of them have from one to three service technicians, while the largest respondent has from 50 to 80 service technicians. Respectively, the number of service calls the companies are managing per week is quite modest: 64% of the companies have ten or less service calls per week and the median number of service calls is eight. 14% of the respondents have over twenty service calls per week. In addition to the differences in the scope of the servicing activities, some of the respondents seemed to be focusing on other lines of businesses than field-service of the focal type of capital goods. Based on the survey, servicing is an important of very important line of business only for 71% of the respondents. Some of the remaining 29% respondents informed that they were mainly involved with the installation works of the capital goods.

After the survey was carried out, the results were validated in discussions with experts from the manufacturing company, and compared with warranty invoicing data from the equipment manufacturer where applicable. All the service invoices and reports from a five-month period in 2004 were analyzed, including 83 invoices from 23 service companies.

V. Results

V.1 Introduction to the Case Company

The equipment manufactured by the case company can be divided into two categories which in this study are called small-scale and large-scale products. The large-scale products are fixed equipment which are fitted to a particular site and have a large capacity. On the contrary, the small-scale products have a smaller capacity but they are not fixed and thus can be transferred to another site if required. In addition, the large-scale products can be equipped with

electronic controller systems that enable remote diagnostics and condition-based maintenance functionalities.

Based on the initial interviews, it was identified that the most used maintenance method in the examined line of business is breakdown maintenance, i.e. the customer site personnel order a service after the equipment is not working properly. Therefore, the context of this case setting enabled us to examine the effects of the unavailability of information in an environment where the maintenance execution is highly time-critical. In some individual situations, there is a maintenance agreement between the customer and a service company, where condition-based maintenance or scheduled maintenance is practiced, but this is more uncommon.

Next, the typical maintenance process in context of the case is examined following the components of defect rectification time.

V.2 Problem Identification Phase

According to the interviews, the defect reporting and confirmation phase is carried out following one of the three possibilities in Figure 1. The most common means is breakdown maintenance, where plant personnel observes that the equipment is not working properly. After that, a service is ordered either by contacting the equipment manufacturer or by contacting a service company. In some cases, a customer plant and a service company have signed a service contract which obliges the service company to regularly, e.g. once a year, service the plant equipment. This is scheduled maintenance, but it is rather rare in the examined industry. The third possibility is condition-based maintenance, where automatic condition monitoring devices set off an alarm that notifies the plant personnel of improper operation. In addition, the service companies have the prospect to take a remote connection to the plant's condition monitoring system in order to gain run-time information of the equipment in the plant. This is, of course, possible only if both the plant equipment are connected to the remote monitoring system and the service company has the required terminal equipment.

In the interviews, the service technicians commented that by using the remote condition monitoring system, the upcoming problems may be recognized before the breakdown occurs. Therefore, in the examined case, it seems that information on the condition of the equipment i.e. pressure and temperature readings provides great assistance to the problem identification phase. The survey was used to determine how often this information is available. Based on the answers, 41% of the service companies have access to remote monitoring information. For two companies, this information is available for over 70% of the equipment serviced, and for the rest of the companies gaining this information, it is available from 4% to 25% of the equipment serviced. As a result, despite the value of remote monitoring information, it seems to be available not too often. In addition, for the equipment not under condition monitoring, the unavailability of information on the failure leads to longer downtimes by increasing the problem

identification time. Nevertheless, the defect identification time is not included in scope of the study, as data on the duration of this phase should be interrogated from site owners that could not be included in the study.

V.3 Preparation Phase

The second step in the defect rectification process is preparation. According to the interviewees, this means that the service technicians load the necessary spare-parts and documents to the service vehicle when leaving from the workshop. As was discussed before, this is a highly information critical phase where gaining advance information on the identity of the equipment and the type of failure are important for effective and efficient preparation. However, based on the survey, there seems to be inadequate data available in this phase. By using the survey, we determined what advance information the service technicians currently have for preparation.

In addition to remote monitoring information, one information source is the customer who orders the service. In the survey, we enquired how often different pieces of information are gained from this source. We found out that information on the type of the product, i.e. whether it is a small-scale or a large-scale product, is acquired the most often, in 66% of the service orders. Description of the failure is gained in 51%, and equipment's manufacturer in 44% of the service orders. Other information pieces are gained much less frequently. Information on the equipment's service history, previously installed spare-parts, and model are gained in about every fifth service order, and equipment's serial number is gained less than in every tenth service order.

The third information source in the preparation phase is the service companies' own records. In the survey, 71% of the companies responded to hold paper records and 11% responded to hold electronic records on equipment locations. Especially the companies that have installed 40% or more of the equipment serviced were all holding records on equipment locations. In principle, these records could be used to identify the piece of equipment to be serviced and thus help in effective preparation, but the research material gave no indication of this. The companies holding records on item locations were not showing better performance than the companies not holding records.

As a result, identification of the equipment to be serviced can take place based on remote monitoring information, customer information, or companies' own records. However, it seems that not one of these means can provide comprehensive information in all situations, or even used together, identity of the product serviced remains a mystery in the preparation phase. In addition, only remote monitoring can provide the technicians with accurate advance information on the condition of the equipment, but this information is gained quite seldom. The implications of improper preparation can be detected in the later steps of the maintenance process.

V.4 Access Gaining Phase

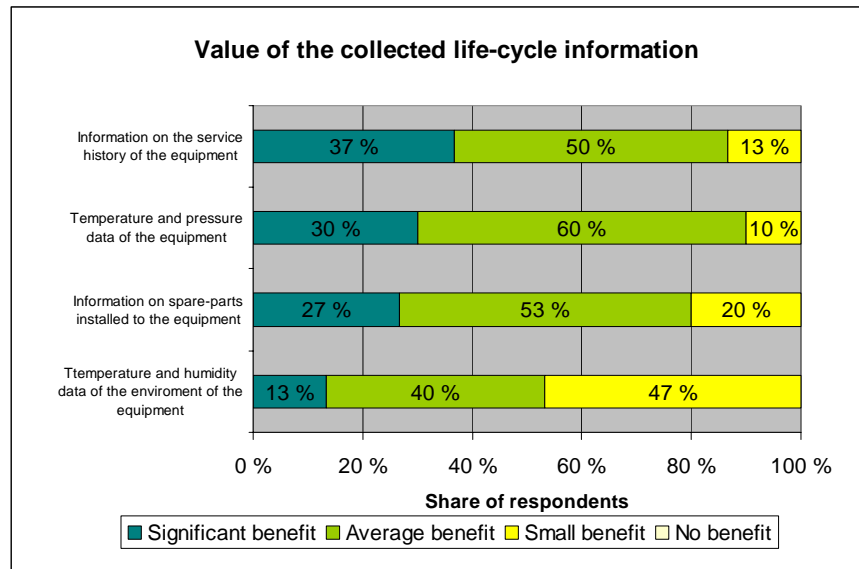


FIGURE 2 THE VALUE OF INFORMATION IN SERVICING OPERATIONS

The third component of the defect rectification process is gaining access to the equipment. In practice, this means that when the maintenance resources are available, a service technician drives to the customer site with his service vehicle and locates the equipment to be serviced. In the examined field-service organizations, this time depends on the service level that the companies are offering and it is agreed upon in the service contract. The response time is regulated also by the service pricing so that the service visits that are carried out during nights and weekends are more expensive than the ones during the office hours. Since the duration of gaining access is controlled by contractual issues, it is not relevant to examine in this context the effects of unavailability of information to the performance of gaining access to the equipment.

V. 5 Diagnosing Phase

After arriving at the customer plant, the service technician seeks to isolate and diagnose the fault. This is an information intensive phase and in addition to doing the diagnosing activities, the service technicians need also to acquire information to support the problem diagnosing. The duration of this phase was determined in the survey by inquiring the average on-site duration of a service visit and the share of on-site time used to problem diagnosing activities, problem fixing activities and inquiring for information. Based on the answers, the average duration of the diagnosing phase is 45 minutes, corresponding to 36% of the average total service visit duration. On average 14 minutes (11% of the total service visit duration) of this time is used for acquiring additional information. The standard deviation for the duration of the diagnosing phase is 27 minutes.

In practice, there are several sources from where to look for information. First of all, there are three possible information

sources on-site. Some pieces of product information can be found from the product itself e.g. information on the type of lubricant is attached to every new product manufactured. In addition, some documents such as electric diagrams are delivered with the product to the site of usage. The problem with these documents is, as the service technicians pointed out in the interviews, that they are seldom found from the plant when needed. The third source of on-site information is the paper documents stored in the service vehicle. However, due to the large number of different products serviced, it is not possible to carry all the required documentation in paper format. Due to these issues, service technicians need to inquire for information from outside the service site. Based on the survey, we determined that the service technicians most typically contact their own office, if information is missing. Most often used medium for transferring information is telephone, but also fax and e-mail are used for transferring technical drawings. However, the service technicians contact the focal manufacturing company on average 0.7 times a month to inquire for information. In total, this encumbers the case company's technical support staff with hundreds of technical inquiries a month that are due to the poor availability of information.

In addition to having technical documents available in problem diagnosing, the literature review revealed that service technicians may benefit from collected life-cycle information. Therefore, the value this information was examined in the survey with a multiple choice question. The service companies were to estimate how beneficial the given pieces of information are. This question included all the pieces of lifecycle information on the devices and their value was estimated in a scale of significant benefit, average benefit, small benefit, and no benefit. The results of this question are presented in Figure 2. The most valuable piece

of life-cycle information seems to be the equipment service history. It was responded to bring significant benefit by 37% and average benefit by 50% of the service companies. About as valuable piece of information seems to be equipment's temperature and pressure data, which was responded to bring significant benefit by 30% and average benefit by 60% of the companies. It was evaluated as a small benefit only by 10% of the respondents. Information on spareparts installed to the equipment was estimated to bring significant benefit by 27% of the respondents. Temperature and humidity data of the environment of the equipment was the least valuable of the given information pieces, almost half of the companies responded that it brings only small benefit to servicing operations. In general, the collected lifecycle information seems to be at least somewhat valuable to all the service companies, as no one answered that some piece of information would not be beneficial at all.

In the survey, the means to improve the fault diagnosing were inquired with an open-ended question. Subjects of improvement for failure diagnosing included information, technology, and training related issues. Information related development needs were dominant and comprised of better availability of existing documentation and needs for currently non-existing documents as trouble shooting diagrams and typical failure documents. Technology related improvement suggestions were automated failure diagnostics tools and remote monitoring devices, which already are in use to some extend. In addition, training held by experienced service technicians was mentioned as a way to improve fault diagnosing. Based on these answers, it seems that better availability of information would indeed improve the fault diagnosing phase. Currently, the service technicians have to work with incomplete information on the serviced equipment, which reduces their efficiency to locate quickly and reliably the problem at hand.

V. 6 Return loop

If the defect cannot be rectified during the service visit, the process returns back to the preparation step which is indicated as the return loop in Figure 1. The problems related to a failed return visit were discussed before, and next we dig deeper into the reasons behind the failing service visits in this case in order to be able to quantify the problems caused by poor availability of information.

An overview of the average situation for a service company in a month is given in Figure 3. Based on the survey answers, the average service call accomplishment ratio for the service companies is 79% (Figure 3: Accomplishment ratio). That means, on average 21% of the service visits go to the return loop. Only for 17% of the respondents the accomplishment ratio was 70% or less, so based on this measure, the maintenance performance of the service companies is somewhat uniform. To assess the reliability of this result, the service call accomplishment ratio was determined based on the warranty service invoice data as well. The survey result received modest support, as the average accomplishment ratio for the services made

under warranty was 75%.

From customer perspective, the down-time continues in breakdown maintenance until the service technician returns for a follow-up service visit to rectify the defect. The time customers have to wait for the follow-up service visit was determined based on the warranty service invoice data. On average, it takes three days for a follow-up visit but the spread is quite large. For 19% of the cases it takes longer than a week and 19% of the follow-up visits can be accomplished during the same day. Therefore, for a customer a failed service visits means several days more of unplanned downtime that cannot be from affecting the customer's perception on the reliability of the manufacturer's products.

To find out why some service visits fail, the failure reasons and their significances (Figure 3: Failure reason) were inquired in the survey. The respondents had to estimate weights for the given failure reasons: lack of spare-parts, lack of documents or information, and lack of tools. In addition, the respondents could fill in other failure reasons and their weights as well. It turned out that the main failure reason is the lack of spare-parts, which causes two thirds of failed service visits. Lack of information or documents is the reason behind 14% of the failed service visits while the lack of tools is the reason in only 3% of the cases. The last 16% is caused by other reasons, which were mainly customer-related and service process-related reasons, such as the customer's contact person being unavailable at the time of visit.

There are several reasons why the service technicians may be lacking of the needed spare-parts while on-site (Figure 3: Spare-part problem reasons). Therefore, the survey was used to determine what the relevant reasons in this particular case are. As a result, the two main reasons for missing spare-parts are that it is not known which parts should be taken with when leaving for service site, and that the spare-part is not stored and it must be ordered. These both account for 35% of the cases when a spare-part is missing. The next significant reasons are that the spare-part is temporary lacking from the service vehicle, and that the spare-part is out of stock. Other reasons account for the remaining 2%.

The service technicians have a need for a great deal of information when carrying out the on-site operations. In the examined case, the information is not always available due to the characteristics typical of most field-service organizations: paper-based documentation is poorly portable, and the amount of documentation is very large [25]. Based on the survey answers, the lack of information is the reason behind 14% of the failed service visits. In order to better understand this failure reason, the respondents were asked to specify the missing of which particular document or piece of information typically prevents from completing a service call. The answers to this open-ended question and their frequencies are presented in Table 1.

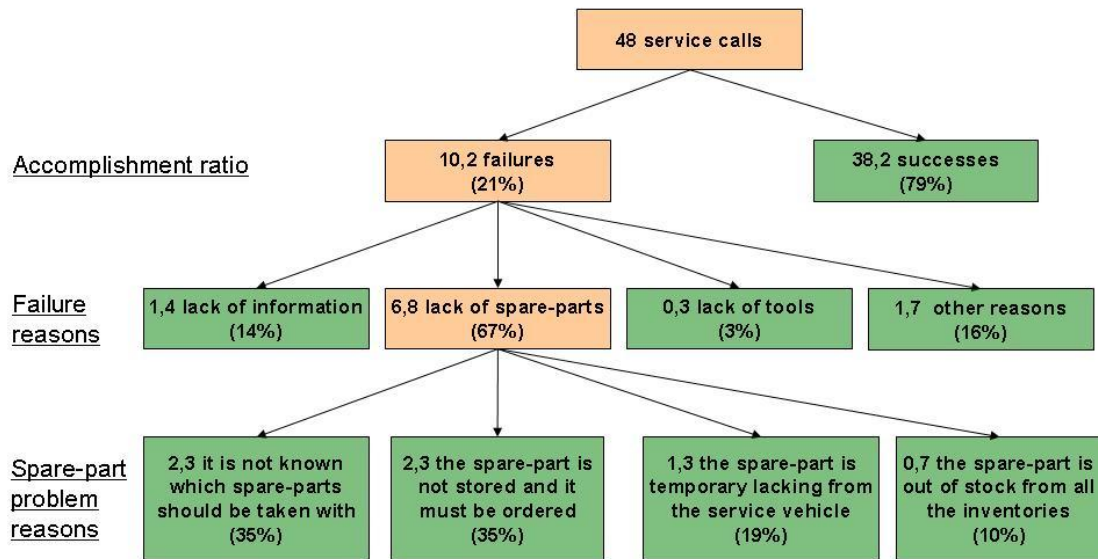


FIGURE 3SERVICE COMPANIES' AVERAGE SITUATION IN ONE MONTH PERIOD

Table 1Typically missing documents or information

Document or piece of information	Mentioned in the survey
Electric diagram	11
Electronic controller's instructions or settings	4
Adjuster's instructions or settings	3
Control settings or parameters	1
Instructions	2
Equipment's special parts	1
Type of lubricant	1
Electrotechnical information	1
Equipment's power	1
Inadequate failure description by the customer	1
Information on is it allowed to maintain the equipment and who will pay for it	1
Inadequate equipment's operating report	1
False information from the customer	1
Total	29

The most typically missing document is electric diagram which was mentioned by 11 of the total 24 respondents to this question. Although this document is delivered to the plant with the equipment, the electricians often lose it during the installation works and therefore it is missing when needed. Other typically missing documents are instructions or settings for the electronic controllers and adjusters. Information on equipment's special parts, type of lubricant, electrotechnical attributes, and equipment's power were all mentioned once as typically missing pieces of technical information. Inadequate failure description by the customer, equipment's operating report, false information from the

customer, and missing of information on typical failures were mentioned as other causes for failed service visits.

One important factor that causes the unavailability of information seems to be the observation that the current availability of documents and information is inadequate for the service companies. Service companies' preferences for the locations where different pieces of information should be available were inquired in the survey. When these results are compared to the current availability of documents, some rather large discrepancies in information's current availability and the wanted availability can be recognized. For the most typically missing document, electric diagram, 80% of the respondents wanted it to be physically attached to the equipment. For the settings and service instructions for electronic adjusters, the second typically missing document, 63% of the respondents wanted it to be available in the service instructions located at the customer plant. In addition, almost half of the respondents wished that at least one of the document types would be available in the Internet. The manufacturer is currently not satisfying these needs and therefore the service companies are facing problems in the information availability.

The observations from the return loop indicate that several of the current failure reasons are related to the unavailability of information. In fact, the study revealed that about 40% of the failed service visits are either directly or indirectly caused by the unavailability of information. Missing document or piece of information is the reason behind 14% of the failed service visits. With better availability of information on the service site, these failures could be eliminated. The single most important reason for a service call failure is insufficient advance information on the spare-parts that will be needed during the service visit. This means the service technicians do not know which spare-parts

should be taken to the service site, and it is the reason behind 24% of the failed service visits. If the service technicians would have advance information on the model of the equipment and possibly on the failure type, they could be better prepared with the proper spare-parts when arriving for the service site for the first time. Having all the possible spare-parts in the service vehicle is not achievable due to the large variety of spares and due to the large size the most often missing component. Therefore, the solution would be advance information that would allow more accurate preparation for the service calls. That way, the service technicians would also be able to prepare themselves with the required tools, the lack of which is currently the reason behind 3% of the failed service visits. These improvements in information availability would ultimately allow the service companies to accomplish 40% of the currently failing service calls, and thus increase the accomplishment ratio from the current 79% to around 87%.

V. 7 Defect Rectification

After a successful failure analysis, the service technician can rectify the defect. According to the service technicians, this can involve cleaning, adjusting, repairing, or component changing activities. According to the survey, this phase takes on average 1 hour 19 minutes corresponding to 64% of the service visit duration. The service technicians commented that the duration of this phase varies a lot, and consequently the results showed rather big variance with a range of 27 minutes to 240 minutes and a standard deviation of 42 minutes.

The defect rectification step can be argued to be the most important phase of the whole defect rectification process. The information needs during the rectification consist of product documentation on product structure, such as diagrams, and settings. The availability of these documents and consequences of non-availability have been included in the above sections addressing diagnosis and the reasons for failed service calls, while the defect rectification phase was measured to identify the share of time used to the corrective work with the equipment.

V. 8 Testing and close-up

The final phase in the defect rectification process is testing and close-up. In the interviews, the service technicians commented that testing is carried out only briefly. In most of the cases this is sufficient, but sometimes the failure recurs quickly because the actual defect was not rectified. Close-up of a service call means creation of a service report and an invoice. There is no standard format for a service report, and typically a service report means information on the invoice items of a service call: number of billed hours, traveling expenses, and cost of spare-parts. However, customers can require more detailed reporting. The manufacturer requires more information for identifying the service product and description of the type of failure in order to pay the warranty service invoice. However, as Christer and Whitelaw [11] argue, there would be more valuable information available

that is not currently reported. The service technician could report his professional view on the cause of fault, consequences of fault, and means of prevention [11]. This information could be used in prevention of the future breakdowns.

The time it takes to create a service report and an invoice is rather short. However, the time it takes to handle the paperwork is longer. In order to study the duration of the reporting phase, we examined how long it takes for the service companies to invoice their customers. In the survey, we inquired the average duration for invoicing the customer after a service visit. The average result for the respondents is 7 days with a range from 1 to 20 days. This result is compared with the invoicing data. From the warranty service invoices, we could determine how many days it has taken from completion of the service call to the creation of the invoice. According to this data, the average duration for invoicing has been much longer – 17 days – and for 12% of the invoices the duration is 30 days or more. Therefore, it seems that the survey results do not reliably represent the actual operations of the service companies in terms of reporting duration. In addition, this indicates that there are inefficiencies in the close-up reporting process that can affect the value of data gathered.

V. 9 Discussion of the results

To provide answer for the first research question, we examined the maintenance execution process of the case in the light of the framework for defect rectification process (Figure 1). Based on our findings, there are several ways how the unavailability of information in field-service affects maintenance execution performance. In terms of maintenance efficiency, the most significant implication is that due to the unavailability of information in the preparation phase, the current service call accomplishment ratio is below 80%. We argue that with better information in the preparation and fault diagnosing phases, the service companies could accomplish up to 40% of the currently failing service calls, and thus increase the accomplishment ratio to around 87%. We emphasize that this improvement can be attained just with better preparation and better availability of information – without affecting the service companies' current spare-part ordering and inventory holding practices.

The second important implication of the unavailability of information is that valuable onsite time has to be spent to acquire information from several sources. Currently 36% of onsite time is spent with problem diagnosing and searching for information. We conclude that the information unavailability in this case was caused by nonconformity of means requested and provided. Better data could help to reduce the problem diagnosing time, and better availability of information could help to reduce the information acquiring time. Therefore, proper tools to access or other arrangements to make relevant information available could cut down the duration of the on-site service operations.

The objective of the second research question was to

find out what are the most critical pieces of information required in the different process phases. We argue that the biggest benefits could come from increasing the effectiveness of the preparation phase. That could be done with information on the identity or type of the equipment to be serviced. If the service technicians knew which equipment they will service, they could prepare better in terms of spare-parts, documents and tools. That would improve effectiveness of preparation. In addition, advance information on the type of the failure would make the preparation more efficient. To improve the on-site operations, product documentation should be better available. In this case, especially electric diagrams and settings for adjusters and controllers are typically missing documents. Based on the results, the problem diagnosing activities could be made more efficient with life-cycle information such as service history and temperature and pressure data for the equipment.

The examined ICT-solutions in the literature part give indication on the means how information could be made better available. For the preparation phase, a system that takes product type and symptoms of the failure as input and propose the likely needed spare-parts would provide considerable assistance, corresponding to case Xerox [18]. To improve the availability of information in the on-site phases, it seems that portable computers could be the solution to ensure the availability of comprehensive product documentation. In addition, there is evidence that portable computers can help also in the reporting phase, where the service companies are currently facing long lead times in invoicing.

Our findings concerning the predictability of duration for the different phases of the defect rectification framework are somewhat contradictory to Knotts's statements. Knotts argues that the duration of problem diagnosing phase is difficult to predict, but the duration of defect rectification phase can be predicted [21]. However, our research material showed the opposite since the standard deviation for the duration of the diagnosing phase is 27 minutes but for the defect rectification phase it is 42 minutes. Greater deviation makes it harder to predict the duration of the defect rectification phase. We contend that the main reason for this poor predictability is the variance in rectification times for different failure types. For example, some service technicians commented that replacement of certain components is exceptionally time-consuming since it requires breaking down the whole equipment.

On the validity of the findings, the set-up of the study with service companies separate from the manufacturer is one factor that reduces the quality of information available to the service providers. Nevertheless, our discussions with representatives from investment goods manufacturers with own service organizations indicate that the results are not far from their experiences. The use of several sets of research material enables assessment of the reliability of the results. For the service call accomplishment ratio and invoicing lead time, the survey results gave a better image of the service

companies' performance than the warranty invoicing data did. This indicates that the service companies may have answered overly optimistically, and it means that the potential of improvement may be even higher than the results point out.

.VI Conclusions

When selecting ICT tools for maintenance operations, it is important to understand which phases in the service process currently lack information and what the potential impact of better information could be. We have 1) demonstrated the magnitude of impact on process performance that unavailable information may have in the context of one case and 2) developed the framework presented by Knotts [21] further to enable analyzing the information needs in and impacts on distinct process phases. Based on our findings, the single most important means to improve the defect rectification process performance can be to provide better information for the preparation phase, which can yield considerable benefits in terms of improved service call accomplishment ratio.

The total improvement potential of better information is considerable especially from the customer viewpoint, as it would be possible to significantly reduce the equipment downtime that the customers are experiencing. Especially, making sure the equipment can be put into condition during the first service visit has a huge effect on the service level experienced by a customer, since she does not have to wait for the second service visit.

The realization of the improvement potential by means of ICT is in the interest of the manufacturer as well, since it ensures more reliable customer service that can increase both customer satisfaction and the company's brand image. From the service company viewpoint, better information would increase operational efficiency of the defect rectification process, which can turn into more business.

Our study proved that the lack of very basic information, here electric diagrams, may be a major reason for service delays, not necessarily the lack of sophisticated tools. Therefore, when selecting ICT tools for maintenance operations, it is important to understand the service technicians' real information needs and fulfill them.

Component of defect rectification framework (Applied from Knotts, 1999)			
Symptom/failure/defect reported and confirmed	Example case	System description	Author
	Palomar Technology International Inc.	Condition-based maintenance system. The maintenance engineer enters temperature and pressure readings from gauges associated with the equipment and vibration information gathered with a magnetic probe. Data is compared with historical data stored in the computer and the system identifies required repairs.	Ives and Vitale, 1988
	Light aircraft manufacturer	A condition-based maintenance system used to monitor the condition of the aircraft engine	Ives and Vitale, 1988
	Otis Elevator Inc.	A self diagnostics control systems that inform the company when maintenance is required.	Ives and Vitale, 1988
Preparation	Xerox	The customer support service system tells the maintenance personnel which spare parts will most likely be needed.	Ives and Vitale, 1988
	A ship engine manufacturer	Diagnostics tool to determine product service and spare-part needs after the failure has occurred. Data about the damaged engine and ship location are transmitted to the manufacturer's headquarters, where the nearest repair facility is identified, and replacement engine or spare-parts are dispatched. The system also guides the ship's crew to prepare the engine for subsequent repair.	Ives and Vitale, 1988
	Sears Roebuck & Co.	The field service personnel can check spare-part availability and place orders using wireless computers. The back-end system schedules a second visit for the service technician to install the part. Previously the technicians had to call the headquarters for availability information and to order the spare-parts. The system has yielded 70% decrease in the back-office support.	Albright, 2000
	An electronic products manufacturer	A centralized diagnosis support system that is used by the call center employees. It advises customers to make small repairs themselves and dispatches a service technician for complex cases.	Pintelon et al., 1999
Access gained	Maytag Corp.	A mobile computer system provides repair workers with updates on the available service calls. The service vehicles can be tracked via the GPS. Since the rollout, the average number of service calls completed by the service persons has increased.	Hamblen, 2005
	Schindler Elevator Corp.	A routing system to assign routes for field service workforce that carries out periodic maintenance operations, breakdown maintenance operations and emergency services. Optimal routes are found by minimizing operational costs while taking into account geographic proximity, technician workload, necessary skills and customer relations.	Blakeley et al., 2003
	Sears Roebuck & Co.	Wireless computers are used to route the field-service personnel. The back-end system forecasts the proper number of technicians needed to serve each day's route and matches each technician's skill set with the jobs on the route.	Albright, 2000
	Southern Co.	Field service personnel get work orders and mapping information to their laptop computers using a wireless connection. Back-end systems take care of routing by taking into account the available workforce, materials and equipment. Imbedded GPS tracks the location of the service call and the crew, which is captured and mapped.	Townsend, 2004
Fault diagnosed & isolated	Honeywell Inc.	Portable diagnostic tool to help the service technicians locate the problem	Ives and Vitale, 1988
	Worthy Down Centre	Provide product information and maintenance history by means of 2D bar-coding. Benefits: faster data entry, improved decision making when carrying out the servicing activities, and reliable identification of serviced equipment.	March and Finch, 1998
	Sears Roebuck & Co.	The company's field service technicians are using wireless computers with the following applications: diagnostic tools, schematics and training materials.	Albright, 2000
	A capital goods company	The company is collecting service call reports to a centralized database. This database serves as a resource for unusual, or first-time, repairs	Zackariasson and Wilson, 2004
Defect rectified	SourceOne Healthcare Technologies	A wireless field service support system to provide to technicians with equipment and site history, parts and customer information, automatic time sheets, e-mail messaging, and inventory management functions.	Anonymous, Wireless News 2004

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Measuring Supply Chain Performance Based on SCOR: A Case Study of a Garment Company in Taiwan

Rong-Chang Chen *, Shun-Chin Du, Yueh-Feng Hu, Siao-Bei Lin, Shiue-Shiun Li

Department of Logistics Engineering and Management

National Taichung Institute of Technology

No. 129, Sec. 3, Sanmin Rd., Taichung, Taiwan 404, ROC

* rcchens@ntit.edu.tw

Tel: 886-4-22196759

Fax: 886-4-22196161

Abstract: The performance of supply chain is an important factor for the success of a company since it greatly affects the ability to provide customer value. Therefore, it is very important for a company to develop independent criteria to evaluate the performance, compare with competitors, and monitor the operation of a company. In the past, many companies tried to develop criteria for measuring their performance of supply chain. However, suitable criteria are hard to develop since the supply chain is generally very complex. The purpose of this study is to develop criteria to measure the performance of supply chain by using the Supply Chain Operations Reference Model (SCOR), which was shown by several previous studies to be an effective tool to develop criteria for measuring performance in diverse industries. To investigate the effectiveness of SCOR, we use the process reference model in SCOR to analyze the current state of a famous garment company's processes and its goals, and quantify the operational performance. Results from this study show that SCOR is a very effective tool to develop performance metrics of the supply chain. Through the use of SCOR, a company can clearly define key performance indices (KPI) to improve their performance.

Keywords: SCOR; Supply Chain Performance; Garment

I. Introduction

There are several obstacles when developing an evaluation system of the supply chain performance (CSC, 2004). First, the evaluation is very hard to execute. Second, functions and processes are usually very complex and lack consistency across a supply chain. Third, supply chain members who have been evaluated are usually not willing to provide true information. Fourth, definitions of evaluated items are different for different supply chain members. In addition, the communications between supply chain partners are usually time-consuming and with low efficiency. Hence, there is a requirement for well-defined metrics and a common language for evaluating the supply chain performance.

Hammer and Champy (2004) stated that we should employ a macroscopic perspective to view a supply chain. The optimization of each member of a supply chain is not

the optimization of the whole supply chain. The main purpose of the supply chain management is integration of these activities through improved supply chain relationships to achieve a global optimization and sustain competitive advantages. Formerly, a company only has to consider their own performance within an organization and focus on processes in their department. However, in recent years, the industry has developed a number of strategies to allow supply chain partners to replace sequential planning, or sequential optimization, with global optimization (Simchi et al., 2003). In sequential planning, each member optimizes its own profit with almost no regards to how its decisions impact other supply chain partners. By contrast, the goal of global optimization is to find what the best for the entire supply chain is.

As we know, companies need a standard model to establish their own metrics of performance, analyze the values of indicators, and improve their supply chain efficiency. Moreover, a common language can improve the communications between the members of the entire supply chain. Recently, the SCOR model (SCC, 2005) is emerging as a powerful and potential tool to analyze a supply chain. It uses a process reference model that can analyze the current state of a company's process and its goals, evaluate operational performance, and compare it with benchmark data. To measure the performance of supply chain, SCOR has developed a set of metrics in five perspectives, including reliability, responsiveness, flexibility, cost, and, assets, which were successfully applied to many industries, such as car, electronics, and so on. In this study, we will also use the SCOR to develop the criteria for the performance of supply chain.

The remainder of this paper is organized as follows. Section 2 gives a brief overview of the structure for measuring the performance of supply chain based on SCOR. The case study is described in Section 3. Finally, conclusions are presented by summarizing the findings in Section 4.

II. Procedure for Measuring Supply Chain Performance

The procedure for measuring the performance of supply chain is shown in Fig. 1.



Fig. 1 The Steps of supply chain performance analysis

The first step is to choose performance metrics. There are five perspectives of metrics in SCOR: reliability, responsiveness, flexibility, cost, and assets. After choosing the metrics, the metrics are defined. Interviews on top managers are performed to ensure that the definitions of the metrics are the same for members within the supply chain. Comparison is made by benchmark data in the third step to find the gap rate. Finally, results are obtained by checking the gap rates and used to improve the performance. The details are mentioned as follows.

1) Choose Performance Metric

There are five perspectives in SCOR and in each perspective a SCOR card can be established. Table 1 illustrates the SCOR card. In the third column, the metric is categorized according to the type of the activity. For example, M1 stands for make-to-stock, M2 represents make-to-order, and so on. The actual and target values are shown in the fourth and the fifth columns, respectively. The gap, i.e., the difference between the actual value and the target value, is shown in the sixth column. Finally, the gap rate is calculated in the last column.

Table 1 SCOR card

SCOR card - (Type Name)						
Metric	Metric Definition	SCOR Categories	Actual	Target	Gap	Gap Rate
...
...

2) Define Performance Metric

A key point for a successful SCOR card is clear definitions of metrics. Therefore, each metric is clearly defined in the second column to avoid confusion between supply chain members. Only an appropriate definition is given is the information helpful. Interviews with managers in the supply chain must be performed to ensure a suitable definition is described.

3) Benchmarking

Most organizations tailor definitions of benchmarking to suit their own strategies and objectives (Shoshannah and Joseph, 2005). In practice, benchmarking usually includes

regularly comparing perspectives of performance (functions or processes) with best practitioners, recognizing gaps in performance, seeking new approaches to bring about improvements in performance, following through with implementing improvements, and following up by monitoring progress and reviewing the benefits. Benchmarking is both internal and external that can give valuable data for improving supply chain performance and has two main benefits (<http://www.benchmarking.gov.uk>, 2005). First, external comparisons place your performance in an industry circumstance, which helps to identify supply chain improvement opportunities. And second, regions, or locations are the best performers. Then you can identify the underlying practices that make the difference and implement those practices across the company.

4) Evaluating and Improving

Benchmarking has been used by managers in different industries to evaluate and improve the quality of their products, work process and procedure, and work performance. By finding those gap rates which are less than a threshold value, managers can understand which metrics have poor performance and should be improved first.

III. THE CASE STUDY

To evaluate the effectiveness of the SCOR model, a garment manufacturing company was selected to do the case study. Garment industry is characterized by high fashion, high creativity, high globalization, low repetition, and low standardization. It is generally difficult to analyze its supply chain and develop its measurements of performance since its processes are very complicated. In addition, it is necessary to use a common language to communicate with each partner across the supply chain as businesses become more and more worldwide. Therefore, an effective tool is much necessary while developing measures for evaluating the performance of the supply chain of garment industry.

The case company (hereafter referred to as J Company) is a holding company with worldwide markets in fabric and garment production. J Company has a capital of about 1 billion and a turnover of about 5.5 billion NT dollars in 2004. J Company is one of the top 500 manufacturing companies and one of the largest manufacturers of knitted fabrics in Taiwan. The headquarters is located in Taipei and it has factories in Mainland China, Vietnam, Thailand, Cambodian, Lesotho, and more. This company has been expanding the overseas undertaking actively all the time in recent years. To meet the change of environment, J Company has been deploying globally and changed its business model. Fig. 2 shows the global deployment of J Company.



Fig. 2 The global configuration of J Company

The as-is and to-be business models of J Company are illustrated in Fig. 3. J Company always tries to employ different e-strategies for improving its operational condition and performance. After employing the supply chain typology analysis, the business model was changed. A global logistics center was set up in charge of integrating two major product business, i.e., fabric division and garment division. Originally, the fabric division and the garment division do business nearly independent, lacking of integration. Its to-be business model integrates the fabric and the garment divisions vertically to take orders jointly to maximize the profit of the company. Once the business model of a company is changed, the processes are also changed. Therefore, it is very important to find appropriate performance metrics. It is important for an enterprise to find out the most appropriate evaluation performance index.

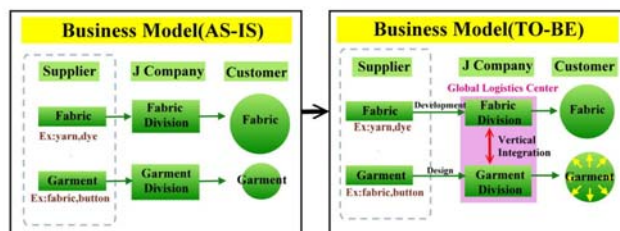


Fig. 3. The as-is and to-be business models of J Company

By using the SCOR model, 3 key performances indicators (KPI) were developed to evaluate the performance, compare with the target value, and to improve the gap between the actual and the target value.

1) Choose Performance Metric

After the interviews with staff in the case company, appropriate evaluation performance indicators from the five perspectives can be selected. The selected indicators are shown in Table 2. The metrics include the cycle time for responding customer's requirements, decision processing time, on-time delivery rate, the supply cycle time of main material, air transportation cost, and order processing cost.

Table 2 The performance perspectives and metrics selected by J company

Perspectives	Metrics
Responsiveness	The cycle time for responding customer's requirements
	Decision processing time
Reliability	On-time delivery rate
	The supply cycle time of main material
Cost	Air transportation cost
	Order processing cost

2) Define Performance Metric

As for the definition of performance metrics, the SCOR model has provided with complete definitions for references. However, to suit the requirements of the practice, the case company had its own definitions for the metrics. After many deep interviews and discussion with some staff of the case company, the definitions of these metrics were finally confirmed. Table 3 shows the definitions of some performance metrics.

3) Benchmarking

Whether its market share, its annual turnover, or its development of own brand, the case company was top in the field of garment industry. As a result, this enterprise was inclined to learn from the precursors to intensify its competitiveness in this field.

The case company selected several similar industries as its models, with an eye to their industrial functioning and results, then evaluate its own characteristics and status quo to set up the most appropriate index for its target.

Table 3 Definitions of performance metrics

Metric	Definition
Cycle time for responding customer's requirements	The time period between on order and responding customer's requirements
Decision processing time	The time period between receiving an order to a most suitable factory
On-time delivery rate	The ratio of the number of on-time-delivery orders to the number of orders
Supply cycle time of main material	The cycle time between placing on order to a supplier of fabrics and receiving the fabrics
Air transportation cost	The cost of transportation by air for delivering garment
Order processing cost	The total cost from receiving an order to shipping an order

4) Evaluation and Improving

Following the procedure mentioned above, the SCOR cards in several perspectives were set up. The description is illustrated in Table 4. Companies can fully or partially refer to SCOR in five perspectives. The advantage is that a company can exactly develop its best model on its own. In this case, J Company did not focus on the assets and the flexibility perspectives. Therefore, the metrics concerning the assets and the flexibility perspectives can be neglected.

Table 4 The SCOR card in the responsiveness perspective

Level 1-SCOR Card (Responsiveness)				
Metric	Actual	Target	Gap	Gap Rate
The cycle time for responding customer's requirements	14 Days	7 Days	7 Days	1
Decision processing time	2 Days	0.5 Days	1.5 Days	3

Table 5 The SCOR card in the reliability perspective

Level 1-SCOR Card (Reliability)				
Metric	Actual	Target	Gap	Gap Rate
On-time delivery rate	70%	90%	20%	0.22
The supply cycle time of main material	28 Days	24 Days	4 Days	0.17

Table 6 The SCOR card in the cost perspective

Level 1-SCOR Card (Cost)				
Metric	Actual	Target	Gap	Gap Rate
Air transportation cost	12 Million	6 Million	6 Million	1
Order processing cost	18 Million	6.8 Million	11.2 Million	1.65

Through SCOR card one can understand the gap between the actual value and the target value of specific metrics. It enables a company to manage performance based

on criteria. The case company established several metrics in 3 perspectives by referring to the SCOR model and from the global viewpoint in order to check the effectiveness of 3 overall evaluation performance indicators.

After completing the SCOR card, the company must decide a threshold value of the gap rate according to its operation state. Indicators exceeding the threshold value of the gap rate are considered to have a poor performance. Because the threshold value of the gap rate is determined by high-level administrators' experiences and the culture of an enterprise, the optimistic administrators will generally set up higher values of threshold of the gap rate. For instance, the efficiency of decision-making has a larger gap rate than the required cycle time of customers at the perspective of responsiveness, providing that the threshold value of gap set up by the administrator is 1.5, indicating that the particular enterprise needs to focus on its improvement of efficient decision-making. Similarly, at the perspectives of reliability and cost, when the index has a higher gap rate than the threshold value of gap, the index indeed needs a great deal of adjustment and improvement.

Table 7 Key performance indicators of J Company

KPI	Actual	Target	Rate
Production cycle time	90 Days	45 Days	Reducing 100 %
Joint order-taking rate	8.55 %	17 %	Increasing 100 %
Order cycle time	120 Days	90 Days	Reducing 25%

Table 7 shows 3 key performance indicators that help the case company to observe the performance of the supply chain from a global viewpoint. The elevation of the overall performance indicators shows that the case company is on its right track of improvement or not.

IV. Conclusions

The supply chain performance is one of the most important factors for the success of a company since it considerably affects the ability to provide customer value. It is, thus, very important for a company to develop independent criteria to evaluate the performance, compare with competitors, and monitor the operation. However, suitable criteria are hard to develop since the supply chain is usually very complicated. The purpose of this study is to develop criteria to measure the performance of supply chain by using the Supply Chain Operations Reference Model (SCOR). To investigate the effectiveness of SCOR, we use the process reference model in SCOR to analyze the current state of a famous garment manufacturer's business processes and its goals, and quantify the operational performance. Results show that

SCOR is a very useful tool to develop performance metrics of the supply chain. Through the use of SCOR, a company can define key performance indicators (KPI) to improve their performance.

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Fuzzy Random Traveling Salesman Problem

Yiwen Lu, Yaodong Ni

Uncertainty Theory Laboratory, Department of Mathematical Sciences

Tsinghua University, Beijing 100084, China

lyw00@mails.tsinghua.edu.cn, nyd00@mails.tsinghua.edu.cn

Abstract: The travelling salesman problem is to find a shortest path from the travelling salesman's hometown, make the round of all the towns in the set, and finally go back home. This paper investigates the travelling salesman problem with fuzzy random travelling time. Three concepts are proposed: expected shortest path, (α, β) -path and chance shortest path according to different optimal desire. Correspondingly, by using the concepts as decision criteria, three fuzzy random programming models for TSP are presented. Finally, a hybrid intelligent algorithm is designed to solve these models, and some numerical examples are provided to illustrate its effectiveness.

Keywords: travelling salesman problem; fuzzy random programming; fuzzy simulation; genetic algorithm.

I. Introduction

The travelling salesman problem (TSP) is to find a shortest path from the travelling salesman's hometown, make the round of all the towns in the set, and finally go back home.

Mathematical problems related to the travelling salesman problem were treated in the 1800s by the Irish mathematician Sir William Rowan Hamilton and the British mathematician Thomas Penyngton Kirkman[3]. The term 'travelling salesman problem' was first used by J.B.Robinson[20] in 1949, which makes it clear that the TSP was already a well-known problem at that time. In 1954, G. Dantzig, R. Fulkerson, and S. Johnson[4] first solved the TSP with 49 cities, which was one of the principal events in the history of combinatorial optimization. Since then, many other researchers have made efforts to find better algorithms to solve large-scale TSP.

Traditionally, the travelling salesman problem considers the distance between two cities as a constant. However, in the real world, uncertainty always exists in travelling salesman problem. Probability theory was introduced into TSP in 1980's. In 1984, M. Mezard[18][21] studied the travelling salesman problem in the case where

the distances are random variables and found the solution under the hypothesis that the replica symmetry is not broken. This kind of TSP was called 'the random link TSP'. Lu presented three types of fuzzy models as fuzzy expected fuzzy expected value model, fuzzy α -path model and most credibility model to solve fuzzy travelling salesman problem in 2005.

While in some cases, we care about the travelling time instead of the travelling distance. Considering the weather or traffic environment, the travelling time from one city to another is uncertain. Sometimes randomness and fuzziness may co-exist in traveling salesman problem in the real world. For instance, the route may changes because of the traffic environment, we can assume the distance as a fuzzy variable. Everyday the speed of travel is random in different time and different weather or traffic circumstance. Therefore, we can get the shortest traveling time between two cities by the highest speed in shortest route, but we can't estimate the worst circumstance. In this case, fuzzy random variable can be introduced into optimization problems with mixed uncertainty of randomness and fuzziness. In this paper, the travelling times are assumed to be fuzzy random variables. Fuzzy random variable was first introduced by Kwakernaak[7][8]. And in the next years, Puri[19], Kruse[6], and Liu[16] developed the concept with different requirements of measurability. In this paper, we introduce the concept of fuzzy random variable initialized by Liu[16] and some relevant concepts to prepare for modelling the fuzzy random traveling salesman problem. Numerous numerical experiments have shown that the fuzzy random simulation indeed works very well. In this paper, we use a fuzzy random number to represent the travelling time between two cities, and define three concepts of shortest path in fuzzy random situation: expected shortest path(ESP), (α, β) -path and chance shortest path(CSP). Correspondingly, by using the three concepts as decision criteria, three fuzzy random programming models are proposed.

This paper is organized as follows: In Section 2, the travelling salesman problem is described. After recalling three ranking criteria for ranking fuzzy random variables in Section 3, Section 4 builds three types of fuzzy random models as expected shortest path model, (α, β) -path

model and chance shortest path model. Then in Section 5, some numerical experiments are given to show the effectiveness of a hybrid intelligent algorithm, which is integrated by fuzzy random simulations and genetic algorithm (GA). Furthermore, Section 6 gives some conclusions.

II. Problem Description

The travelling salesman problem may be stated as follows: A salesman is required to visit each of some given cities once and only once, starting from one city and returning to the original place of departure. What route should he choose in order to minimize the total distance travelled?

In order to model the travelling salesman problem, we first introduce the following indices and parameters:

$i = 1, 2, \dots, n$: cities;

d_{ij} : travelling time between city i and j ;

x_{ij} : decision variables, where $x_{ij} = 0$ means that the salesman does not go from i to j , otherwise $x_{ij} = 1$ means that the salesman goes from i to j .

Then in order to minimize the total travelling time, we have the following model:

$$\min \sum_{i \neq j} d_{ij} x_{ij} \quad (1)$$

$$s.t. \sum_{j=1}^n x_{ij} = 1, \quad i = 1, 2, \dots, n \quad (2)$$

$$\sum_{i=1}^n x_{ij} = 1, \quad j = 1, 2, \dots, n \quad (3)$$

$$\sum_{i,j \in s} x_{ij} \leq |s| - 1, \quad 2 \leq |s| \leq n - 2, s \subset \{1, 2, \dots, n\} \quad (4)$$

$$x_{ij} \in \{0, 1\}, \quad i, j = 1, \dots, n, \quad i \neq j. \quad (5)$$

The constraint (2) requires the salesman just goes out of city i once and the constraint (3) requires salesman just enters city j once. Hence, every city must appear once and only once in the route. The constraint (4) means that there is no circle in the route.

In the above model, d_{ij} denotes the distance between two cities and is deterministic. In the following models, we will consider d_{ij} as the travelling time between two cities and assume it to be a fuzzy random variable. D denotes the feasible set defined by the constraints (2-5).

III. Fuzzy Random Variable

In this section, we will give some basic concepts of fuzzy random theory. The interested reader may refer to Liu[14] to see the fuzzy random theory.

We firstly recall the concepts of possibility, necessity, and credibility of a fuzzy event. Let ξ be a fuzzy variable with membership function μ . Then the possibility, necessity, and credibility of a fuzzy event $\{\xi \geq r\}$ can be defined by

$$\text{Pos}\{\xi \geq r\} = \sup_{u \geq r} \mu(u),$$

$$\text{Nec}\{\xi \geq r\} = 1 - \sup_{u < r} \mu(u),$$

$$\text{Cr}\{\xi \geq r\} = \frac{1}{2} (\text{Pos}\{\xi \geq r\} + \text{Nec}\{\xi \geq r\}).$$

Definition 1 (Liu and Liu[16]) A fuzzy random variable ξ is a function from the probability space $(\Omega, \mathcal{A}, \text{Pr})$ to the set of fuzzy variables such that $\text{Pos}\{\xi(\omega) \in B\}$ is a measurable function of ω for any Borel set B of \mathcal{R} .

III.1 Expected Value

Next, we will introduce several concepts as ranking criteria for the preparation of modelling the traveling salesman problem. The first concept is the expected value of a fuzzy random variable. Before we give the first criterion for ranking fuzzy random variables, the concept of expected value of fuzzy variable will be given as follows:

Definition 2 (Liu and Liu[15]) Let ξ be a fuzzy variable. The expected value of ξ is defined by

$$E[\xi] = \int_0^{+\infty} \text{Cr}\{\xi \geq r\} dr - \int_{-\infty}^0 \text{Cr}\{\xi \leq r\} dr$$

provided that at least one of the above two integrals is finite.

Based on the concept of expected value of fuzzy variable, the expected value of fuzzy random variable can be shown as:

Definition 3 (Liu and Liu[16]) Let ξ be a fuzzy random variable. Then its expected value is defined by

$$E[\xi] = \int_0^{+\infty} \text{Pr}\{\omega \in \Omega \mid E[\xi(\omega)] \geq r\} dr -$$

$$\int_{-\infty}^0 \text{Pr}\{\omega \in \Omega \mid E[\xi(\omega)] \leq r\} dr$$

provided that at least one of the above two integrals is finite.

Let ξ and η be two fuzzy random variables. Liu[14] suggested that $\xi > \eta$ if and only if $E[\xi] > E[\eta]$, where E is the expected value operator of fuzzy random variable.

III.2 Chance Measure

The second concept is the chance measure of a fuzzy random event.

Definition 4 (Liu, Gao and Liu[14]) Let ξ be a fuzzy random variable, and B a Borel set of \mathcal{R} . Then the chance of fuzzy random event $\xi \in B$ is a function from $(0, 1]$ to $[0, 1]$, defined as

$$\text{Ch}\{\xi \in B\}(\alpha) = \sup_{\Pr\{A\} \geq \alpha} \inf_{\omega \in A} \text{Cr}\{\xi(\theta) \in B\}.$$

Let ξ and η be two fuzzy random variables. Liu[14] suggested that $\xi > \eta$ if and only if $\text{Ch}\{\xi \geq \bar{r}\}(\gamma) > \text{Ch}\{\eta \geq \bar{r}\}(\gamma)$ for some predetermined levels \bar{r} and $\gamma \in (0, 1]$.

III.3 Critical Value

Next we will introduce two critical values as optimistic value and pessimistic value to measure fuzzy random variables.

Definition 5 (Liu[14]) Let ξ be a fuzzy random variable, and $\gamma, \delta \in (0, 1]$. Then

$$\xi_{\text{sup}}(\gamma, \delta) = \sup \{r \mid \text{Ch}\{\xi \geq r\}(\gamma) \geq \delta\}$$

is called the (γ, δ) -optimistic value to ξ , and

$$\xi_{\text{inf}}(\gamma, \delta) = \inf \{r \mid \text{Ch}\{\xi \leq r\}(\gamma) \geq \delta\}$$

is called the (γ, δ) -pessimistic value to ξ .

Let ξ and η be two fuzzy random variables. Liu[14] suggested that $\xi > \eta$ if and only if, for some predetermined confidence levels $\gamma, \delta \in (0, 1]$, we have $\xi_{\text{sup}}(\gamma, \delta) > \eta_{\text{sup}}(\gamma, \delta)$, where $\xi_{\text{sup}}(\gamma, \delta)$ and $\eta_{\text{sup}}(\gamma, \delta)$ are the (γ, δ) -optimistic values of ξ and η , respectively. Similarly, Liu[14] suggested that $\xi > \eta$ if and only if, for some predetermined confidence levels $\gamma, \delta \in (0, 1]$, we have $\xi_{\text{inf}}(\gamma, \delta) > \eta_{\text{inf}}(\gamma, \delta)$, where $\xi_{\text{inf}}(\gamma, \delta)$ and $\eta_{\text{inf}}(\gamma, \delta)$ are the (γ, δ) -pessimistic values of ξ and η , respectively.

With the above concepts as different ranking criteria, we can model fuzzy random traveling salesman problem in different forms according to different types of optimization requirements.

IV Fuzzy Random Models

IV.1 Expected Shortest Path Model

Expected value model (EVM), which is to optimize some expected objectives with some expected constraints, is a widely used method in solving practical problems with uncertain factors. In uncertain environments, objective

functions and constraint functions always cannot be compared directly since they always involve uncertain variables. Since in fuzzy travelling salesman problem the shortest path cannot be achieved directly, it may be required to minimize the expected travelling time under the constraints.

Definition 6 A path x^* is called the expected shortest path(ESP) if

$$E \left[\sum_{i \neq j} d_{ij} x_{ij} \right] \geq E \left[\sum_{i \neq j} d_{ij} x_{ij}^* \right]$$

for any path x satisfy (2.2)-(2.5).

In order to satisfy this type of request, we can build an expected valued model as:

$$\begin{aligned} \min \quad & E \left[\sum_{i \neq j} d_{ij} x_{ij} \right] \\ \text{s.t.} \quad & \sum_{j=1}^n x_{ij} = 1, \quad i = 1, 2, \dots, n \\ & \sum_{i=1}^n x_{ij} = 1, \quad j = 1, 2, \dots, n \\ & \sum_{i,j \in s} x_{ij} \leq |s| - 1, \quad 2 \leq |s| \leq n - 2, \\ & s \subset \{1, 2, \dots, n\} \\ & x_{ij} \in \{0, 1\}, \quad i, j = 1, \dots, n, \quad i \neq j. \end{aligned}$$

IV.2 (α, β) -Path Model

Chance-constrained programming (CCP) is a new modelling philosophy deals with uncertainty (traditionally randomness) which is initialized by Charnes[1][2]. It is applied to solve problems with the request that chance constraints should hold with at least some given confidence levels. In travelling salesman problem, a decision-maker may not want to minimize the expected travelling time, but to consider the risk. So we can establish an (α, β) -path model to meet this type of requirement.

Definition 7 A path x^* is called (α, β) -path if

$$\left(\sum_{i \neq j} d_{ij} x_{ij} \right)_{\inf} (\alpha, \beta) \geq \left(\sum_{i \neq j} d_{ij} x_{ij}^* \right)_{\inf} (\alpha, \beta)$$

for any path x satisfy (2.2)-(2.5).

Following the idea of fuzzy random CCP, we can present the CCP models as follows:

(α, β) -path model(minimaxCCP):

$$\begin{aligned}
 \min \quad & \bar{f} \\
 \text{s.t.} \quad & \text{Ch} \left\{ \sum_{i,j} x_{ij} d_{ij} \leq \bar{f} \right\} (\alpha) \geq \beta \\
 & \sum_{j=1}^n x_{ij} = 1, \quad i = 1, 2, \dots, n \\
 & \sum_{i=1}^n x_{ij} = 1, \quad j = 1, 2, \dots, n \\
 & \sum_{i,j \in s} x_{ij} \leq |s| - 1, \quad 2 \leq |s| \leq n - 2, \\
 & s \subset \{1, 2, \dots, n\} \\
 & x_{ij} \in \{0, 1\}, \quad i, j = 1, \dots, n, \quad i \neq j.
 \end{aligned}$$

IV.3 Chance Shortest Path Model

We have built two types of model based on the expected value and pessimistic value. Another useful tool to solve practical problems in uncertain environments is dependent-chance programming (DCP). Because many goals cannot be obtained absolutely in practice, a decision-maker may want to achieve his goal with maximal chance. Dependent-chance programming (DCP) is initialized by Liu[9] to maximize the chance functions of optimization goals. The readers may also refer to Liu[14] to see how DCP is used to solve different problems. Accordingly in fuzzy random travelling salesman problem, a decision-maker may want to maximize the chance that the total travelling time does not exceed some given time under the constraint. First, for a given travelling time \bar{f} , we obtain a fuzzy random event: $f(x, d) = \sum_{i \neq j} d_{ij} x_{ij} \leq \bar{f}$.

Definition 8 A path x^* is called chance shortest path (CSP) if

$$\text{Ch} \left\{ \sum_{i \neq j} d_{ij} x_{ij} \leq \bar{f} \right\} (\alpha) \leq \text{Ch} \left\{ \sum_{i \neq j} d_{ij} x_{ij}^* \leq \bar{f} \right\} (\alpha)$$

for any given \bar{f} and α .

Hence, we can build a chance shortest path model based on fuzzy random DCP:

$$\begin{aligned}
 \max \quad & \text{Ch} \left\{ \sum_{i \neq j} d_{ij} x_{ij} \leq \bar{f} \right\} (\alpha) \\
 \text{s.t.} \quad & \sum_{j=1}^n x_{ij} = 1, \quad i = 1, 2, \dots, n \\
 & \sum_{i=1}^n x_{ij} = 1, \quad j = 1, 2, \dots, n \\
 & \sum_{i,j \in s} x_{ij} \leq |s| - 1, \quad 2 \leq |s| \leq n - 2, \\
 & s \subset \{1, 2, \dots, n\} \\
 & x_{ij} \in \{0, 1\}, \quad i, j = 1, \dots, n, \quad i \neq j.
 \end{aligned}$$

V. Numerical Experiments

In the above three models, there exist several uncertain functions with fuzzy random variables as the expected shortest path $E \left[\sum_{i \neq j} d_{ij} x_{ij} \right]$, the (α, β) -path

$\min \left\{ \bar{f} \mid \text{Ch} \left\{ \sum_{i,j} x_{ij} d_{ij} \leq \bar{f} \right\} (\alpha) \geq \beta \right\}$ and the chance $\text{Ch} \left\{ \sum_{i,j} x_{ij} d_{ij} \leq \bar{f} \right\} (\alpha)$. We use fuzzy random simulations introduced by Liu[13] to estimate the three fuzzy random functions.

To find a shortest path for a salesman, we need to design some heuristic algorithm. We embed the fuzzy random simulations, which are used to simulate the above three types of uncertain functions, into GA to design a hybrid intelligent algorithm. In this section, we will show the effectiveness of the hybrid intelligent algorithm by the following three numerical experiments.

Now let us consider a traveling salesman problem with 10 cities as shown in Table 1, which gives the coordinates of the cities.

Table 2 shows the matrix in which each triple denotes a fuzzy random variable.

Note that the traveling times are assumed to be fuzzy random variables, denoted by a form of triangular fuzzy variable (a, b, ρ) , where a and b are given crisp numbers and ρ is a exponential distributed random variable with the expected value is c .

Before running the hybrid intelligent algorithm, we set the parameters as follows: *pop.size* is 50, the number of generations is 500, the number of stochastic simulation cycles is 1000, the probability of crossover p_c is 0.1, the probability of mutation p_m is 0.7, and the parameter a in the rank-based evaluation function is 0.05.

After a run of the hybrid intelligent algorithm with the parameters above to solve the expected shortest path

Table 1: Coordinates of Cities

No	City	Coordinate	No	City	Coordinate
1	Beijing	(3639,1315)	6	Handan	(3493,1696)
2	Shanghai	(4177,2244)	7	Qinhuangdao	(3904,1289)
3	Tianjin	(3712,1399)	8	Shijiazhuang	(3488,1535)
4	Baoding	(3569,1438)	9	Tangshan	(3791,1339)
5	Chengde	(3757,1187)	10	Zhangjiakou	(3506,1221)

Table 2: Fuzzy Random Matrix

0	1000,1073, exp(1146)	90,111, exp(132)	110,142, exp(174)	140,174, exp(208)	350,408, exp(466)	220,266, exp(312)	220,267, exp(314)	130,154, exp(188)	130,163, exp(196)
	0	900,964, exp(1128)	960,1010, exp(1060)	1057,1137, exp(1217)	800,876, exp(952)	910,993, exp(1076)	920,989, exp(1058)	924,984, exp(1044)	1100,1223, exp(1346)
		0	120,148, exp(176)	180,217, exp(254)	300,369, exp(438)	191,221, exp(251)	230,262, exp(294)	60,99, exp(138)	230,272, exp(314)
			0	170,314, exp(358)	220,269, exp(318)	300,367, exp(434)	100,126, exp(152)	200,243, exp(286)	190,226, exp(262)
				0	490,573, exp(656)	140,179, exp(218)	390,440, exp(490)	130,156, exp(182)	220,253, exp(286)
					0	500,578, exp(656)	120,161, exp(202)	400,465, exp(530)	410,475, exp(540)
						0	400,483, exp(566)	100,124, exp(148)	340,404, exp(468)
							0	300,361, exp(422)	250,315, exp(380)
								0	250,315, exp(380)
									0

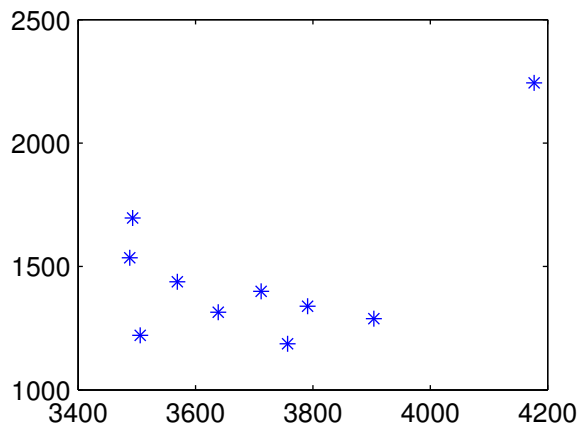


Figure 1: Positions of Cities

model, an optimal path is presented as $7 - 2 - 9 - 4 - 3 - 8 - 5 - 6 - 1 - 10$ and the total traveling time is 2050.

For solving the (α, β) -path model with different confidence levels, we run the algorithm with the same parameters. The (α, β) -path with different (α, β) are shown as in Table 3.

Similarly, we run the hybrid intelligent algorithm for chance shortest path model. The chance shortest path with different \bar{f} are presented as in Table 4.

In order to show the effectiveness of the hybrid intelligent algorithm, we solve the (α, β) -path model with $(\alpha, \beta) = (0.8, 0.8)$. We compare solutions when different parameters are taken in the algorithm ($a = 0.05, Gen = 500, Pop.Size = 50$). The errors shown in Table 5 are calculated by the formula as $(\text{actual value} - \text{optimal value}) / \text{optimal value} \times 100\%$.

Table 5: Comparison Solutions of the (0.8, 0.8)-Path

P_c	P_m	(0.8, 0.8)-path	traveling time	Error(%)
0.1	0.2	10-9-5-3-1-8-4-6-7-2	2301.59	0.12%
0.2	0.3	10-8-1-3-6-5-4-9-7-2	2299.99	0.05%
0.5	0.5	3-4-6-8-5-10-7-1-9-2	2299.11	0.01%
0.7	0.8	8-9-7-5-3-1-10-4-6-2	2299.70	0.04%
0.7	0.9	9-7-4-6-8-3-5-1-10-2	2298.78	0.00%

Table 3: (α, β) -Path

(α, β)	(α, β) -Path	(α, β) -traveling time
(0.9, 0.9)	4 – 1 – 5 – 3 – 7 – 9 – 6 – 10 – 8 – 2	2423.96
(0.9, 0.8)	10 – 6 – 7 – 8 – 5 – 4 – 3 – 9 – 1 – 2	2359.68
(0.8, 0.9)	6 – 7 – 9 – 3 – 2 – 4 – 10 – 8 – 1 – 5	2341.88
(0.8, 0.8)	9 – 7 – 4 – 6 – 8 – 3 – 5 – 1 – 10 – 2	2298.78
(0.7, 0.9)	10 – 5 – 8 – 4 – 3 – 1 – 9 – 7 – 6 – 2	2256.84

Table 4: The Chance Shortest Path

f	the chance shortest path	chance
3000	1 – 9 – 7 – 10 – 4 – 8 – 2 – 3 – 5 – 6	0.9689
2500	3 – 9 – 7 – 5 – 6 – 1 – 10 – 8 – 4 – 2	0.9662
2300	6 – 8 – 5 – 9 – 7 – 4 – 10 – 1 – 3 – 2	0.9554
2200	10 – 1 – 6 – 7 – 8 – 4 – 3 – 5 – 9 – 2	0.8755
2100	10 – 7 – 1 – 9 – 5 – 3 – 4 – 8 – 6 – 2	0.6338
2100	10 – 7 – 1 – 9 – 5 – 3 – 4 – 8 – 6 – 2	0.6338
2000	4 – 6 – 3 – 1 – 10 – 8 – 9 – 7 – 5 – 2	0.4265

VI. Conclusion

We introduced fuzzy random theory into traveling salesman problem and solve it with mixed uncertainty of randomness and fuzziness in this paper. After the concepts of fuzzy random theory were presented, three types of fuzzy random models as expected shortest path model, (α, β) -path model and chance shortest path model were built. A hybrid intelligent algorithm integrated by fuzzy random simulations and genetic algorithm was designed and the results of the numerical examples were given to illustrate the effectiveness of the hybrid intelligent algorithm.

Acknowledgments

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The Quadratic Shortest Path Problem and its Genetic Algorithm

Linzhong LIU^{1,2}, Bing WU³, Yinzhen LI¹, Jianning YU¹

1. Institute of System Engineering, Lanzhou Jiaotong University, Lanzhou 730070, China

2. Department of Mathematical Sciences, Tsinghua University, Beijing 100084, China

3. The West Logistic Corporation Limited of Gansu, Lanzhou 730000, China

Email: lzliu@orsc.edu.cn

Abstract: The quadratic shortest path (QSP) problem is to find a path from a node to another node in a given network such that the total cost includes two kinds of costs, say direct cost and interactive cost, is minimum. The direct cost is the cost associated with each arc and the interactive cost occurs when two arcs appear simultaneously in the shortest path. In this paper, the concept of the quadratic shortest path is initialized firstly. Then a spanning tree-based genetic algorithm is designed for solving the quadratic shortest path problem. Finally, a numerical example is given.

Keywords: graph; network; shortest path; genetic algorithm.

I. Introduction

The shortest path (SP) problem has a long history in the combinatorial optimization. Since the SP problem was initialized, it was studied by many researchers and has been applied in wide varieties. The classical SP is to find the shortest, namely the least cost, path from the origin node to the destination node in a given network, where the cost of the path is defined as the sum of the costs of the arcs in the path and the costs are assumed to be non-negative.

There are varieties of extensions both in models and algorithms of SP after it was initialized and thousands papers with respect to various SPs and algorithms in recent years can be retrieved by a quickly searching in the web. For example, Balachandhran and Randan [2], Pettie [20] studied the all pairs SP; Pattanamekar and Park etc.[3], Frigioni and Marchetti-Spaccamela [5] investigated the dynamic and stochastic SP; Davies and Lingrascite [6] designed a genetic algorithms for the dynamic and stochastic SP; Bousoño-Calzon and Figueras-Vidal [7] explored an algorithm by using the Hopfield neural networks; Miller-Hooks and Mahmassanicite[8] studied SP in stochastic time-varying networks; Chen and Tang [9] introduced minimum time paths in a networks

with mixed time constraints; Granat and Guerriero [10], Modesti and Sciomachen [11] gave the algorithms of the multi-criteria shortest path, respectively; Chen and Yang [19] introduce the algorithm for finding the first k shortest paths in a time-window network; Bose, Maheshwari and Narasimhan [21] initialized the bottleneck shortest paths; Okada [22] studied the SP with fuzzy arc lengths; Godor, Harmatos and Juttner [24] initialized the inverse SP and Daganzo [25] the time-dependent SP. Some of them are listed in the references [2]–[26]. Some of the extensions are NP-hard. As another extension of the SP, we initialize the quadratic shortest path (QSP) problem and formulate the QSP as a quadratic 0–1 programming in this paper.

This paper is organized as follows. Firstly, we initialize the concept of quadratic shortest path (QSP) problem in the Section . Then a spanning tree-based heuristic genetic algorithm is given in Section by using heuristic approach and a numerical example is given in Section ??.

II. The Preliminaries and the Mathematical Model of QSP

Firstly, let us recall some preliminaries and define some notations. Throughout this paper, all the graphs are simple direct graph. Let G be a graph with $E(G)$ and $V(G)$ as its arcs set and nodes set, respectively. Assume that $E = E(G) = \{e_1, e_2, \dots, e_{|E|}\}$, $V = V(G) = \{v_1, v_2, \dots, v_{|V|}\}$, $m = |E|$, $n = |V|$ and the ordering pair (u, v) , $u, v \in V(G)$ denote the arc from node u to node v . For a node $v \in V(G)$, $d_G(v)$ denotes its degree and $N^+[v]$, $N^-[v]$, $N_e^+[v]$ and $N_e^-[v]$ denote the sets $\{u|(u, v) \in E(G)\}$, $\{u|(v, u) \in E(G)\}$, $\{(u, v)|(u, v) \in E(G)\}$ and $\{(v, u)|(v, u) \in E(G)\}$, respectively. For a subset S of E or V , $G[S]$ and $|S|$ denote the subgraph induced by the subset S and the cardinality of the set S , respectively. Additionally, for a subgraph T of G and an arc $e = (u, v) \in E(G)$, $T + e$ or $T + (u, v)$ denotes the graph obtained by adding arc $e = (u, v)$ to T and $T - e$ or $T - (u, v)$ denotes the graph obtained by removing arc $e = (u, v)$ from T .

The QSP is to find a path from a node to another

node in a given network such that the total cost includes two kinds of costs, say direct cost and interactive cost, is minimum. The direct cost is the cost associated with each arc and the interactive cost occurs when two arcs appear simultaneously in the shortest path. Let d_i and w_{ij} be the direct cost of the arc $e_i \in E$ and the interactive cost of arcs $e_i, e_j \in E(G)$, respectively, $i, j = 1, 2, \dots, |E(G)|$. Assume that the required path P is the path from the node 1 to the node $|V|$ in this paper. The decision variables $x_i = 0$ or 1 , $i = 1, 2, \dots, |E|$, indicate that each arc i is either in the path or not and \mathbf{x} is the vector consists of x_i , $i = 1, 2, \dots, |E|$. Then the path P can also be denoted by such a vector \mathbf{x} and the cost function of the path \mathbf{x} can be defined as

$$f(\mathbf{x}) = \sum_{i=1}^{|E|} d_i x_i + \sum_{i=1}^{|E|} \sum_{j=i+1}^{|E|} w_{ij} x_i x_j. \quad (1)$$

For convenience, we briefly take the index k of arc e_k or node v_k to denote the k th arc e_k in arcs set E or the k th node v_k in the nodes set V in the following process. Then the mathematical model of QSP can be formulated as follows:

$$\begin{aligned} \max f(\mathbf{x}) &= \sum_{i=1}^{|E|} d_i x_i + \sum_{i=1}^{|E|} \sum_{j=i+1}^{|E|} w_{ij} x_i x_j \\ \text{s.t. } \sum_{i \in N_e^+[v]} x_i - \sum_{j \in N_e^-[v]} x_j &= d, \quad v \in V(G), \\ x_i &= 0 \text{ or } 1, \quad i = 1, 2, \dots, |E|, \end{aligned} \quad (2)$$

where

$$d = \begin{cases} 1, & \text{if } v = 1, \\ 0, & \text{if } v \neq 1 \text{ or } |V|, \\ -1, & \text{if } v = |V|. \end{cases}$$

It is clear that the model (2) of QSP is quadratic 0-1 programming. It is well-known that the quadratic programming is NP-hard, especially the quadratic 0-1 programming. So we will focus on the algorithm designing of QSP in the remain parts of this paper. It is also generally accepted that the genetic algorithm is an efficient ways to solve the NP-hard problems. For the SP, the related exposition related to SP is initialized by Cheng and Gen [23]. To design the genetic algorithm of QSP, we introduce a Lemma as follows.

Lemma 0.1 [27] *Let G be a connected simple graph and T be a spanning tree of the graph G . If $(u, v) \in E(G)$ satisfies $(u, v) \notin E(T)$, then there is a unique cycle in $T + (u, v)$.*

On the basis of Lemma 0.1, we design a spanning tree-based genetic algorithm for solving the model (2) in the next Section.

The encode method and evolution operation are the universal problems in the current genetic algorithms for

the SP and its extensions. Firstly, different paths from the origin node to the destination node include a variable number of the nodes and a random arcs series usually does not correspond to a path. Furthermore, the evolution operation such as the crossover and mutation operations can't be performed efficiently because two paths usually haven't had any common nodes or arcs except the end node 1 and n of the paths. For example, Cheng and Gen [23] have designed a comprise approach-based genetic algorithm of the multi-criteria SP. In Cheng and Gen's algorithm, the chromosome is encoded as the path from the origin node to the destination node. In next Section, we explore a completely new encode method and evolution operators.

III. Genetic Algorithm

In the following process, we shall design the representation, crossover, mutation and selection operation of the spanning tree-based genetic algorithm for solving the QSP. As stated in the Section , the encode method and evolution operation are the universal problems in the current genetic algorithm for the SP. Aim at the purpose to solve these problems, we shall design the oriented tree-based crossover, mutation and evaluation operation by encoding the chromosome as a spanning tree. By such an encode method, there is a unique path from the origin node to the destination node and by using some spanning tree-based heuristic evolution operations, the algorithm completely overcome the defects of the current genetic algorithm with respect to SP. Additionally, the merits of such an encode method are that the chromosomes produced by the crossover and mutation are also feasible.

III. 1 Representation

Assume that $m = |E|$ and $n = |V|$. There are many ways to represent a solution of the optimization problem in genetic algorithm. In this paper, we employ a spanning tree-based encoding method to define the chromosomes of the QSP. We employ a spanning tree X which is denoted by an arcs set with fixed set cardinality $n - 1$ to encode a chromosome of the QSP, where $X = \{x_1, x_2, \dots, x_n\}$ and each x_i represents an arc in the spanning tree and its value is equal to the index of the corresponding arc. It is clear that such a chromosome includes a unique path from the node 1 to the node n .

In the evolution process, we must perform some network search operation such as finding the cycle in the graph $T + e$ or the unique path in T from the node 1 to the node n , where T is a chromosome (tree) and $e \in E(G) \setminus E(T)$. So the chromosome is converted to an oriented tree when perform the crossover and mutation operations. Clearly, It is very convenient to find such a

cycle or path by using the oriented tree.

Definition 0.1 The weight of the chromosome X , denoted by $W(X)$, is defined as

$$\sum_{i \in P} d_i x_i + \sum_{i=1}^{|E|} \sum_{j=i+1}^{|E|} w_{ij} x_i x_j,$$

where P is the unique path from the node 1 to the node n in X . The optimal chromosome is such a chromosome X that the weight of $W(X)$ is optimal.

By such an encoding method, the crossover and mutation operations are really a set-based genetic operations and the decoding process are also convenient to be realized by finding the path from the node 1 to the node n in the chromosome X .

III. 2 Initialization Process

The initialization is an important process in genetic algorithm serving as the role of initializing the chromosomes. We take pop_size to denote the number of chromosomes. We initialize chromosomes $X_1, X_2, \dots, X_{pop_size}$ by repeating the following algorithm pop_size times, where T denotes a spanning tree of the graph $G(V, E)$.

The initialization algorithm:

- Step 1.** Set $T = \emptyset$. Randomly select nodes $u_0 \in V(G)$, $v_0 \in N(u_0)$. Set $T \leftarrow T + (u_0, v_0)$.
- Step 2.** Randomly select a node $u \in V(T)$ with $N(u) \setminus V(T) \neq \emptyset$. Randomly select a node $v \in N(u) \setminus V(T)$. Set $T \leftarrow T + (u, v)$.
- Step 3.** Repeat Step 2 until $|E(T)| = |V(G)| - 1$.
- Step 4.** Set $X_i \leftarrow T$ and stop.

Theorem 0.1 The obtained tree in the initialization algorithm is a spanning tree.

Proof: Because the arc (u, v) in the Step 2 has a common node u with $V(T)$, the obtained graph T is obviously a connected graph. Additionally, the node v in the Step 2 is selected from $N(u) \setminus V(T)$, this implies that T is cycle free. Therefore, a spanning tree is obtained when $|E(T)| = |V(G)| - 1$.

III. 3 Crossover Operation

Let $P_c \in (0, 1)$ be the crossover probability. In order to determine the parents for the crossover operation, we repeat the following process pop_size times: randomly generating a real number r from interval $(0, 1]$, the chromosome X_i is selected to crossover if $r < P_c$. We denote

the selected parents by X'_1, X'_2, \dots and divide them into the following pairs:

$$(X'_1, X'_2), (X'_3, X'_4), (X'_5, X'_6), \dots$$

Based on Lemma 0.1, we take the chromosomes pair (X'_1, X'_2) as the example to illustrate the crossover process. The Figure 1 is a numerical example. Randomly generate an integer k from interval $[1, t]$, where

$$t = |E(X'_1) \setminus (E(X'_1) \cap E(X'_2))| = |E(X'_2) \setminus (E(X'_1) \cap E(X'_2))|.$$

After that, randomly select two sets $S_1 \subset E(X'_1) \setminus (E(X'_1) \cap E(X'_2))$ and $S_2 \subset E(X'_2) \setminus (E(X'_1) \cap E(X'_2))$ with cardinality k . Follows from Lemma 0.1, for each arc $e \in S_1$ (or $e \in S_2$), there is a unique cycle, says C_e , in $X'_2 + \{e\}$ (or $X'_1 + \{e\}$) with the arc e on it. Then we can perform crossover operation as follows: randomly select an arc $e' \in E(C_e)$ and set $X'_2 \leftarrow X'_2 - \{e'\} + \{e\}$ (or $X'_1 \leftarrow X'_1 - \{e'\} + \{e\}$) (Figure 2, where (a) and (b) are X'_1 and X'_2 before crossover, (c) and (d) are these after crossover).

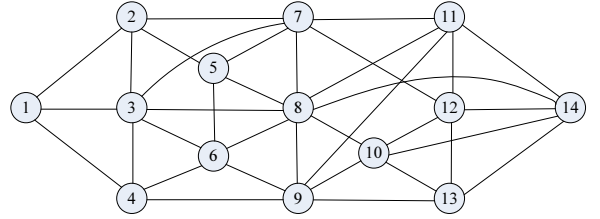


Figure 1: A numerical example with 14 nodes and 35 arcs

Crossover algorithm:

- Step 1.** Convert the chromosome X'_1 and X'_2 to the oriented trees T_1 and T_2 .
- Step 2.** Set $t = |E(X'_1) \setminus (E(X'_1) \cap E(X'_2))| = |E(X'_2) \setminus (E(X'_1) \cap E(X'_2))|$.
- Step 3.** Randomly generate an integer k from interval $[1, t]$.
- Step 4.** Randomly select two sets S_1 and S_2 :

$$S_1 \subset E(X'_1) \setminus (E(X'_1) \cap E(X'_2)),$$

$$S_2 \subset E(X'_2) \setminus (E(X'_1) \cap E(X'_2)),$$

$$|S_1| = |S_2| = k.$$

- Step 5.** For every arc $e \in S_1$, Find the unique cycle C_e in $T_2 + \{e\}$. Randomly select an arc $e' \in E(C_e)$, $e' \neq e$. Set $X'_2 \leftarrow X'_2 - \{e'\} + \{e\}$.

Step 6. Perform the same operations as Step 5 between T_1 and S_2 .

For a spanning tree T , if we indicate a node as the root of T , then the spanning tree can be converted to an oriented spanning tree by using the following method. Let P be a path from the root to a node v . The direction of the path P is defined as the direction go away from the root to the node v in the path P and the direction of an arc in $E(P)$ is defined as the same direction of the path P . By such a way, an oriented spanning tree is defined. Based on such an oriented tree T , we design an algorithm to find the cycle C_e in the Step 5 of the crossover algorithm. For arc $e = (u, v)$, $P_{[s,t]}$ denotes the segment in the path P between the vertices s and t .

The algorithm to find the cycle C_e :

- Step 1.** Start from the node u , along the predecessor node of u , find the path P^u from the root to the node u . If $v \in V(P^u)$, the cycle C_e is found and set $C_e = P_{[u,v]}^u + \{e\}$, stop. Otherwise, go to next step.
- Step 2.** Start from the node v , along the predecessor node of v , find the path P^v from the root to the node v . If $u \in V(P^v)$, the cycle C_e is found and set $C_e = P_{[u,v]}^v + \{e\}$, stop. Otherwise, go to next step.
- Step 3.** Start from the root node, along the path P^v or P^u to find the the last common node s of the path P^v and P^u , set $C_e = P_{[u,s]}^u + P_{[s,v]}^v + \{e\}$.

It is clear that the new chromosome obtained by such crossover operation is also a feasible.

III. 4 Mutation Process

In this section, we will design an oriented tree and knowledge-based heuristic mutation operator. Let $P_m \in (0, 1)$ be the mutation probability. We employ the following operator to select the chromosome to be mutated: for $i = 1$ to pop_size , randomly generate a random number r from interval $(0, 1)$; if $r \leq P_m$, then the chromosome X_i is selected to be mutated. The idea of the mutation operation is also originated from Lemma 0.1. Firstly, randomly select an integer k from interval $[1, |E(G) \setminus E(X_i)|]$. Then randomly select k different arcs e_1, e_2, \dots, e_k from set $E(G) \setminus E(X_i)$. For each arc e_j , $j = 1, 2, \dots, k$, it follows from Lemma 0.1 that there is a unique cycle C_{e_j} in $X_i + \{e_j\}$. The mutation is performed on C_{e_j} as follows: randomly select an arc $e'_j \in E(C_{e_j})$ such that $e'_j \neq e_j$, set $X_i \leftarrow X_i - \{e'_j\} + \{e_j\}$. The mutation operation is summarized as follows.

Mutation algorithm:

- Step 1.** For $i = 1$ to pop_size , repeat Step 2 to Step 3.

Step 2. Randomly generate a random number r from interval $(0, 1]$. If $r \leq P_m$, then go to Step 3. Otherwise, go to Step 1.

Step 3. Randomly select an integer k from interval $[1, |E(G) \setminus E(X_i)|]$ and randomly select k different arcs e_1, e_2, \dots, e_k from set $E(G) \setminus E(X_i)$. For $j = 1$ to k , repeat Step 4.

Step 4. Find the unique cycle C_{e_j} in $X_i + \{e_j\}$. Randomly select an arc $e'_j \in E(C_{e_j})$ such that $e'_j \neq e_j$, set $X_i \leftarrow X_i - \{e'_j\} + \{e_j\}$.

Clearly, such a mutation can also ensure that the new chromosome is also a spanning trees.

In order to accelerate the convergence speed of the designed genetic algorithm, some heuristic methods can be used in the mutation operator. The base idea is to give each arc in the set $S = E(G) \setminus E(X_i)$ a selecting probability according to the weight of the arcs when we perform mutation operation on X_i . Assume that $S = E(G) \setminus E(X_i) = \{e'_i | i = 1, 2, \dots, |S|\}$. The selecting probability of the arc $e'_i \in S$ is defined as $f(e'_i) = (1/w'_i) / \sum_{e'_j \in S} (1/w'_j)$. Let $P_i = \sum_{k=1}^i f(e'_k)$, $i = 1, 2, \dots, |S|$, and $P_0 = 0$. Then the arcs in $S = E(G) \setminus E(X_i)$ is selected by spanning roulette wheel when we select the arc e_j in the above process operation. The detail operation is similar as that in the selection operation and we omitted here.

III. 5 Evaluation

The evaluation process is to calculate the fitness of chromosomes so as to evaluate the chromosomes. In the designed algorithm, the fitness f_i of the i th chromosome X_i is defined as the reciprocal of the weight $W(X_i)$ (see Definition 0.1), $i = 1, 2, \dots, pop_size$. The evaluating function is defined as

$$Eval(X_i) = f_i \Big/ \sum_{k=1}^{pop_size} f_k, i = 1, 2, \dots, pop_size.$$

III. 6 Selection Process

The selection process is to select the offsprings of the chromosomes in the genetic algorithm. Let $P_i = \sum_{k=1}^i Eval(X_k)$, $i = 1, 2, \dots, pop_size$, and $P_0 = 0$, then we employ the spanning roulette wheel to select the chromosomes: randomly generate a number $p \in (0, 1]$; if $p \in (P_{i-1}, P_i]$, then the chromosome X_i is selected. The following is the algorithm.

Selection algorithm:

Step 1. Let $k = 1$, repeat Step 2 until $k = \text{pop_size}$.

Step 2. Randomly generate a number $p \in (0, 1)$. If $p \in [P_{i-1}, P_i)$, then chromosome X_i is selected and let $k = k + 1$.

III. 7 Genetic Algorithm

Step 1. Randomly initialize *pop_size* chromosomes.

Step 2. Update the chromosomes by crossover process and mutation process.

Step 3. Calculate the objective values of the chromosomes.

Step 4. Calculate the fitness of each chromosome according to the objective values.

Step 5. Select the chromosomes by spanning the roulette wheel.

Step 6. Repeat Step 2 to Step 5 for a given number times.

Step 7. Report the best chromosome as the optimal solution.

IV. Conclusions

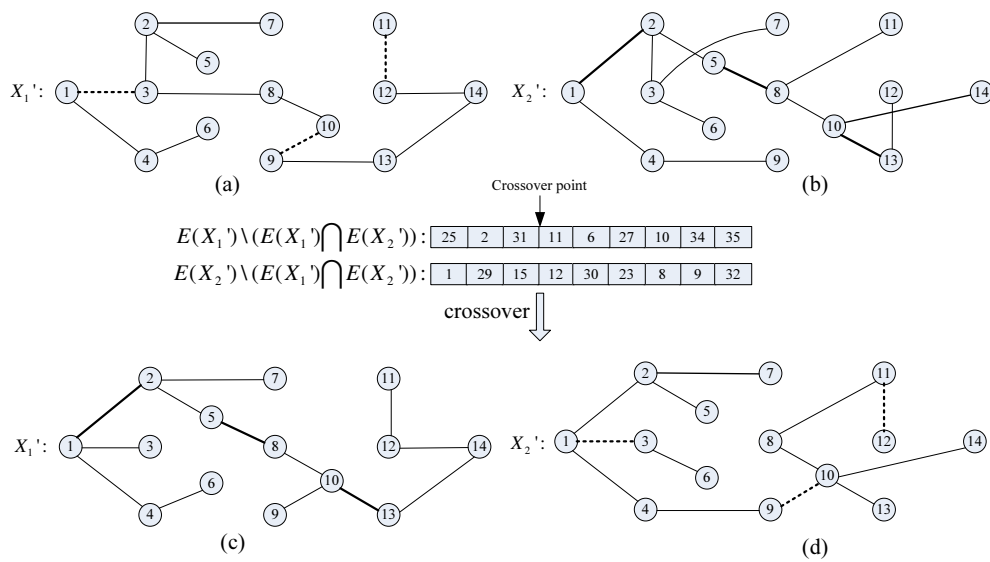
In this paper, an oriented spanning tree-based heuristic genetic algorithm is designed for solving the quadratic shortest path problem. Finally, a numerical example is given.

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Figure 2: The crossover operation of X_1 and X_2 .

Moving Beyond the Dyad: Multi-Tier Supply Chain Integration in the Aerospace Industry

Dr Andrew White¹, Dr Zaher Mohdzain²

Centre for Logistics and Supply Chain Management¹ and Information System Research Centre²

Cranfield School of Management

Cranfield University

Cranfield

Bedford

MK43 OAL

United Kingdom

Abstract: This paper presents a case study on how multi-tier supply chain integration is being achieved via the use of information systems in the aerospace industry. It is based on interviews conducted with three organizations across the supply chain and an IT vendor who supplied the technology. The study finds that by using a new set of technological standards, namely Web Services, data can be taken from the systems of three disparate organizational systems and then used to help an integrated product team from three organizations manage the supply chain. In order to capture the benefits of this technology, the development of a supply chain mindset, integration of marketing and logistics activities and observing demarcation of what issues can and cannot be discussed via the multilateral relationships need to be addressed. The contribution of the paper is that emergent information systems can be used in a multi-tier context to address the problem of the Forrester effect, a phenomenon that has plagued supply chains for decades.

Keywords: SCM, E-logistics

I. Introduction

The global aerospace industry is currently enjoying a period of substantial growth, following the slump in sales that resulted from passengers' reluctance to fly after the tragic events of September the 11th. Aerospace is a sector that contributes a significant proportion of national wealth to countries such as the USA, UK and France, and it consists of four key sectors: civil aircraft, military aircraft, missiles and space. The aerospace industry consists of a supply chain that starts with prime contractors such as Boeing and Airbus, then has systems and major equipment suppliers, sub-system and major component suppliers come next, which is followed by component suppliers. This supply chain is supported by a miscellaneous range of other suppliers in areas such as information systems and manufacturing equipment. The industry can be characterized in the following terms: high levels of technological and scientific intensity; high cost and high-risk programs; long development and payback cycles; low volume, high value

products; civil-military linkages; international collaboration in design and development; central role of Government as sponsor, customer, regulatory and market gatekeeper; high barriers to entry; highly safety critical; long service life (AIGT, 2003). As with any industry, aerospace is in a continual state of change. Recent developments in the aerospace supply chain include: an increased use of supplier development activities to improve their capabilities (Reed and Walsh, 2002); an increased level of outsourcing, which has had the negative consequence of a reduction in the level of control over information for changes in supply and demand (Bales et al. 2004); an increased focus on large-scale integration of systems and platform assembly by those higher up the supply chain, and the optimization of manufacturing and supply chain operations through the adoption of lean principles (Williams et al., 2002); continual challenges in seeking appropriate, markets vs. hierarchies, supply chain relationships (Rossetti and Choi, 2005); the integral role of people and information technology management as a source of competitive advantage (Russell and Hoag, 2004).

This paper will present and analyse a case study conducted on an aerospace Original Equipment Manufacturer (OEM), which serves customers comprising of more than 500 airlines, 4,000 corporate and utility aircraft and helicopter operators, 160 armed forces and 2,000 marine based organisations. Their annual sales total approx. \$9 billion, of which 55 per cent are services revenues. The paper will start by reviewing the literature concerning supply chain management and the use of information systems as a means to improve performance in this area. It will present the rationale for the methodology that was employed and how this was operationalized. The results of the study will then be presented, including: how the technology that integrates multiple tiers in the supply chain works; the motivational antecedents that were responsible for it being developed and deployed; and the factors that were seen as being responsible for enabling the benefits attributed to the system being realised; and the benefits attributed to it.

II. Supply Chain Management

Supply chain management is a concept that is emerging in recognition that buyer-supplier relationships need to be managed beyond logistics and procurement functions

(Lambert *et al.*, 1998; Cooper *et al.*, 1997). In the literature, supply chain management has been defined as a “*connected series of activities that are concerned with planning, coordinating and controlling of materials, parts and finished goods from suppliers to customers*” (Stevens, 1989), or “*the management of upstream and downstream relationships, with suppliers and customers, to deliver superior customer value at less cost to the supply chain as a whole*” (Christopher, 1998). As supply chains often involve more than a dyadic relationship, Mentzer *et al.*, (2001) defined it as “*a set of three or more entities (organizations or individuals) who are directly involved in the upstream and downstream flows of one or more of products, finances and/or information, from a source to a customer*”.

Research in supply chain management encompasses a number of evolving factors in relation to how organizations cooperate and compete. These factors include the use of virtual teams (Bal *et al.*, 1999), sharing risks and rewards (Cooper and Ellram, 1993), integration of business processes (Stevens, 1989; Christopher, 2000), improved information sharing (Mason-Jones and Towill, 1999; Morash, 2001), and developing long-term relationships with key suppliers (Cousins, 1999; Schonsleben, 2000). Managing a single organization within a larger collaborative environment also requires a different set of competencies, such as in managing interorganizational processes (Garcia-Dastugue and Lambert, 2003) and exploiting information systems and technology to facilitate multi-tier integration (White and Daniel, 2003).

Within the management of supply chains, two paradoxes are present, which create a level of uncertainty as to what strategy supply chain managers should employ. This can be articulated in a number of ways. For example, should an organization seek to make its operations and supply chain more “lean” (Womack and Jones, 1994; Karlsson and Par, 1996) through the removal of waste (minimising inventories, reducing process inefficiencies and minimising obsolete stock) or more “agile” (Christopher, 2000) (where excess capacity is required to respond to sudden changes in factors such as demand)? Secondly, should an organisation adopt a competitive position in its relationships with suppliers (Lewis and Yildirim, 2002), and thus create a high rate of turnover of suppliers, or should it invest in longer-term collaborative relationships with suppliers (Cousins, 1999; Schonsleben, 2000)?

III. Information Systems In The Supply Chain

The use of interorganizational systems to link up different actors within a supply chain is not a new concept that originated with the advent of the Internet. These systems have been utilized by organizations for a number of years, combined with the medium of EDI (electronic data interchange), to facilitate electronic trading (Cunningham and Tynan, 1993). Whilst EDI systems brought benefits to trading partners, its use was limited due to high costs and limited content (Frohlich, 2002) and low levels of flexibility

in its implementation and operation (Nurmilaakso *et al.*, 2002). Nevertheless, researchers in interorganizational systems can learn much from EDI implementations, for example, in understanding the role of dominant buyers (Webster, 1995), due to the similarities between these two technologies (Soliman and Janz, 2004).

Interorganizational systems built upon the foundation of an organization's internal information systems, often referred to as ERP (Enterprise Resource Planning), are increasingly being used to manage processes that interface or integrate with customers and suppliers (Shaw, 2000). These ERP systems integrate information and information-based processes within and across functional areas, and employ reference models or process templates that claim to embody good practices within an industry (Kumar and Hillegersberg, 2000). As the importance of extending the orientation of the management of business processes, from within the organization, to between organizations (Clark and Stoddard, 1996), the evolution of information systems designed to manage supply chains occurred (Stefansson, 2002; Nedede-Amadi, 2004). These are defined as information systems that: facilitate demand and manufacturing planning and communication between trading partners, synchronize activities within the supply chain and maintain the provision of timely information (Tarn *et al.*, 2002); provide the capability to transfer more accurate and timely information that results in higher levels of visibility of demand and inventory in a supply chain (Patterson *et al.*, 2003); facilitate market mechanisms (a means to conduct a business transaction) and coordination flows (the sharing of information to coordinate the flow of products) (Garcia-Dastugue and Lambert, 2003); and are not confined to a single organizations processes, programs, data repositories but are able to interoperate with other systems that manage links in the supply chain (Yang and Papazoglou, 2000).

The important roles that information systems and technology play in the operations and management of supply chains have repeatedly been highlighted in the literature. However, much of this research is conceptual in nature (see Manthou *et al.*, 2004, Lin and Lin, 2004, Swaminathan and Tayur, 2003; Strader *et al.*, 1998 as examples), and thus a paucity of empirical papers exists. Previous research has indicated, for example, the impact of information systems and technology in increasing the performance of supply chains (Frohlich, 2002; Goutsos and Karacapilidis, 2004; Jayaram, *et al.*, 2000; Alkadi *et al.*, 2003), the alignment between supply chain strategy and business strategy (Williams *et al.*, 1997), and overall growth and profitability (Kotha and Swamidass, 2000; Byrd and Davidson, 2003). On a more operational level, the adoption of information systems and technology has been linked to an increase in product offerings and customer service levels (Kincade *et al.*, 2001), quality and timeliness of production information (Brandyberry *et al.*, 1999), lowering the total cost of supply and increasing the order fulfilment rate (Lin *et al.*, 2002). Even the perception about trading partners' technology adoption, according to previous research, could improve the

supply chain relationship between both parties (Kent and Mentzer, 2003).

A paradox also exists in the effect that information systems have on interorganizational relationships, which bears similarities to ones observed in interorganizational relationships in general. In their “move to the market” hypothesis, Malone *et al.*, (1987), suggest that increased use of interorganizational information systems will enable a greater use of markets relative to hierarchies. In contrast, in their “move to the middle” hypothesis, Clemons *et al.*, (1993) assert that due to the existence of relationship specific investments, this move to the market will not occur, rather that “*the firm will rely on fewer suppliers than before, with whom the firm will have close and long-term relationships and with whom the firm will cooperate and coordinate closely*”. In recent studies on the impact of Internet-based electronic marketplaces on buyer-supplier relationships, it was found that these entities are having an impact on the characteristics of interorganizational relationships (White and Daniel, 2004; White, *et al.*, (2004).

This review of the literature has demonstrated the increasing importance of supply chain management to contemporary organizations, and the pivotal role that information systems undertake in enabling high levels of operational performance in this area. However, both the practice of supply chain management and the use of information technologies in this domain are in a state of evolution. Therefore, there is a continual possibility of innovative practices emerging through the syntheses of developments in these two areas.

IV. Methodology

The objective of this study was to explore the potential role of emergent information systems and technologies in enabling innovative models that would increase the level of supply chain performance. The study seeks to explore a new domain for the purpose of theory generation. Such strategy would require the use of inductive, qualitative methods rather than deductive, quantitative research methods which, in contrast, is more appropriate for theory testing (Hussey and Hussey, 1997; Locke, 2001). As inductive methods are more frequently operationalized through case studies (Eisenhardt, 1989; Yin, 1989), this approach was therefore adopted. The value of the case study approach, according to Hoskisson (1999), also lies in its ability to consider theory in the context of the rich picture of the organisation studied, including its unique idiosyncrasies.

The OEM was selected because it was undertaking activities that aimed at integrating multiple tiers in its supply chain. This was something that in the experience of the authors was a very uncommon practice in how contemporary supply chains operate, and which a review of the literature substantiated. Given that problems which characterise supply chains, such as demand amplification (Forrester, 1961; Lee, *et al.* 1997), span multiple tiers in the chain, it is fair to assume that technological interventions that span

these tiers should warrant academic study. Therefore, the study adopted the following research question: to investigate the phenomenon of multi-tier integration systems (MTIS) and to examine the technical and managerial competencies needed to operate in this mode.

The supply chain under investigation involves a highly specialised manufacturing process for which there are only a very small number of suppliers globally. Moreover, the manufacturing process utilizes high quality specialist alloys, for which global demand is constrained and shortages frequently occur. The process, which is presented as Figure 1, shows how customer demand is received by the Final Build operation in the OEM. This is then communicated to the Module Build manufacturing cell, again within the OEM. From here the demand signal is passed on to a tier 1 supplier, who in this case is a producer of highly engineered metal components. They in turn pass on the signal to a tier 2 supplier of specialist materials. Inventory is positioned all along this supply chain and moves as a consequence of demand information signals.

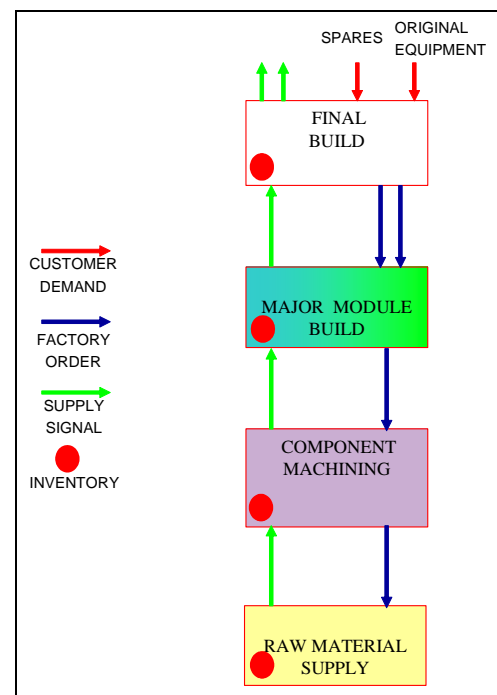


FIGURE 1 – THE OEM'S SUPPLY CHAIN

In order to investigate the use of the OEM's multi-tier integration eleven interviews were undertaken, in both the UK and in the US, with each actor in this process (see Table 1 for details). Each interview lasted between one and two hours and was tape-recorded and transcribed. The interview findings were supplemented by supporting documentation from the OEM, its suppliers and the technology vendor and from external commentators.

Organisation	OEM	Tier Supplier 1	Tier 2 Supplier	IT Vendor
Industry Sector	Aerospace	Industrial Manufacturing	Material	IT
Supply Chain Staff Interviewed	4	4	1	1
Location of Interviews	UK	US	US	UK

TABLE 1 – INTERVIEWS CONDUCTED

V. Results

V. 1 Motivational Antecedents

The motivational antecedents that were responsible for the development and deployment of the information system that integrated multiple tiers in the supply chain stemmed from a need to reduce the demand amplification that was occurring across the supply chain. This supply chain can be characterized by the following phenomena: it plays a crucial role in the building of the OEM's core product, the current build time is 120 days and has a target to be reduced to 40; demand information frequently fails to cascade down the supply chain, thus leaving suppliers working with incorrect or out of date forecast information; the consequence of this is either shortages or excesses of inventory, both of which incur financial consequences; to date there has been no means to enable visibility of demand, supply and inventory across the supply chain; due to the volatility of supply and demand signals there is a low level of reliance on the interorganizational processes that are currently in place.

The demand amplification in the supply chain was being caused, from an external perspective, by a post 9/11 growth in sales and shortages of supply for materials such as titanium. However, internal factors were also responsible. The consequence of this was a supply chain that was under performing, with the consequential impact on costs and revenue. It was described in the following terms by one supply chain manager from the OEM:

"In simplistic terms I would say that 50% of the noise [schedule variation] is generated internally from our organization and 50% by the supply chain not being able to support our delivery dates."

This demand variation appears to of been exacerbated by the adoption of "lean thinking" in the aerospace industry (Womack and Jones, 1994). Low levels of inventory, coupled with deficient processes can lead to a under performing supply chain, as described by a manager from the OEM:

"The elimination of waste and all of that type of activity is absolutely right for any organization, I agree with that. However, I believe that lean and systematic removal of waste from a process, or from any manufacturing process, can only

be achieved providing you've got stability [in demand] and you've got capable processes. The problem as I see it is that our internal manufacturing facilities and suppliers have responded with the systematic removal of inventory. The problem with removing inventory without improving your processes is that it makes you very exposed."

When looking across the supply chain, this phenomenon is exacerbated by the fact that the OEM, hitherto, has had no direct communication channel with the tier two supplier. It is this supplier who is the first to witness shortages of material, which have a consequential impact on the poor performance of the supply chain.

"The situation is that all our problems don't lie with the first tier suppliers. The first tiers often put their hands up and say it's not my fault, it's the material supplier. The problem is he [the material supplier] does not have direct communication with the OEM."

There would appear to be certain circumstances, under which multi-tier integration is appropriate, in other words, an emergent "design science" (van Aken, 2004). So what are these circumstances? Firstly, from a commercial perspective, that the number of alternative suppliers must be relatively low and the value of the transactions undertaken with them relatively high. Secondly, from an operational perspective, that the production time must be greater than the customer lead time. And finally, from a technical (and product safety) perspective, that the product must have a high impact on safety and possess a high level of technical risk.

V. 2 The Multi-Tier Information System

The MTIS works by taking data from the OEM, the tier 1 supplier and the tier 2 supplier and presenting it in a common format. The data is accessed via a website, which all three parties have access to, and regular teleconferences are held to discuss the content. This process is presented as Figure 2, which shows how the information system enables an integrated product team across the supply chain.

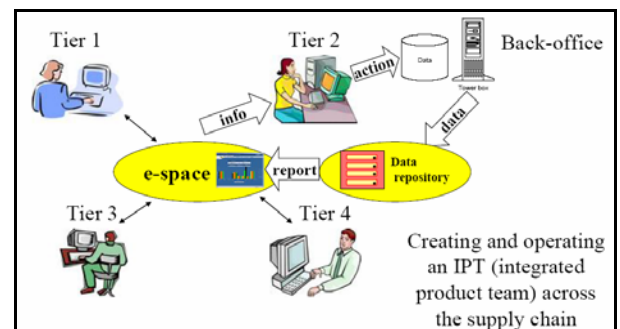


FIGURE 2 – THE INFORMATION SYSTEMS ENABLED MULTI-TIER INTEGRATED PRODUCT TEAM

The types of data which the information system manages are: inventory, its location and status (e.g. work in progress); the forecasts for future demand; and customer orders. The system uses Web Services as an underpinning technology and is based on the J2EE standard. The benefit of this type of technology was suggested to be twofold and is described

as:

"The system has got 2 layers to it. It's got a data transport layer, which means you can transport data without having to redefine it, and the process and application layer. So the application which visualises the data has been designed with the data in mind. So these 2 things sit together, so you've got a transport system and an application bolted together. And that's important because the transport system allows everybody to feed in their data without redefining the process."

"The one thing that I didn't want to do was to work outside of the core ERP system, and the benefit that the multi-tier system had was that it was using direct data that could be readily updated from our ERP system. That was absolutely pivotal. I didn't want to create another ERP system within the supply chain, going all the way down and all the way back up."

V. 3 Managerial Challenges and Implications

The use of the MTIS required a number of non-technological changes to take place in order for the potential benefits to be captured. These changes covered factors such as the emergence of a supply chain mindset, the integration of marketing and logistics functions and understanding the boundaries concerning what could be discussed and communicated via the multi-tier relationship.

V. 4 A Supply Chain Mindset

The adoption of information technology often brings with it a subsequent need for a new mindset within the organisation (Stevens, 1989; Orlikowski, 1992). The use of a MTIS was no different in this respect. What enabled this change was the ability of the information system to share data across multiple functions and organizations, and use this data to coordinate a unified response.

"What the IT does is that it enables people beyond the first tier supplier to have weekly or bi-weekly meetings given a set of data that is not open for debate. Everybody's got the same data and will start planning around issues that might hit us if we don't do something in 6 – 7 months time."

This in turn gave a new perspective to operators concerning the consequences of decisions they made and constraints that the parts of the supply chain, that they hitherto had no visibility over, were under.

The value of getting the people from [the OEM] to be able to start understanding that there isn't an infinite capacity out there."

V. 5 Marketing / Logistics Integration

The separation of the marketing and logistics functions of an organization is increasingly being seen as a major inhibitor to a high performing supply chain. Hence the emergence of the concept and practice of demand chain management. This case illustrates this point, in that the use of the MTIS brought these two departments together to work in a much more coordinated manner:

"The purchasing people in the first tier supplier would normally not have any visibility of the interaction between us and the customer facing department. The use of multi-tier integration meant they saw the 2 year horizon that we were giving their commercial people. This enabled them to work with the commercial people and to be able to conduct a lot better planning of their procurement activity."

Funny enough it provided clear transparency for the first tier suppliers as well, so the purchasing organisation at long last started to understand what sales people were doing, and the planning people could plan around that in the mill [tier 2]. This also enabled the sales people and the planning people within the tier one organization to work around a common set of data, and these people could be all together in the same virtual room or whatever you want to call it. This ensured everybody understood the key issues.

V. 6 Multi-Tier Relationship Boundaries

Operating multi-tier relationships, rather than just dyadic relationships, requires a realization of what the norms are that should cover these new types of relationships. These types of relationships challenge the normal dyadic structure of relationships: OEM to tier one, and then tier one to tier two. The whole point of such an exercise is that some factors are no longer solved on a bi-lateral basis, rather a multi-lateral one. The following insight from a supplier shows one aspect of the demarcation that needs to take place:

"You certainly have to be more open with the three way relationship. However, there are still things that are out of bounds. Pricing is one of them. But as far as working out issues such as quality and schedules, that makes perfect sense."

V. 7 Realized Benefits

The major benefit of the multi-tier information system was the moving from a reactive management of the supply chain to a proactive one. The situation prior to the use of the MTIS was that *"nobody knew there was a problem till there was a problem. Then you were in a highly reactive mode"*. With the MTIS *"because we take a 12-month view, we're always looking ahead to see where the shortfall is because we actually ask them [the supplier] to give us the view of their output for 12 months in support of our product. Now what this shows is that we can look ahead and can see if they are planning to produce less than what we need. Now we are able to say OK, well, that's what you've got planned for the next 12 months and you won't have any major cause to change that pattern unless we do something."*

This has enabled the performance of the supply chain to improve from schedule adherence rates of around 25 – 50% before the MTIS, to 100% when it was implemented. This improved performance has been enabled by an increased level of operational responsiveness within the suppliers business. This improved responsiveness in the tier two supplier is described in the following terms:

"What they say now is look, we're prepared, on a basis of what we're seeing, to create raw material in bulk form at

a rate per month. We're not going to wait for your orders, we're going to plan to actually smelt and process at a set rate. So effectively they're saying that they've got confidence now because they can see through our signal without having to second guess what the tier one supplier is saying to them."

The consequence of this was that the lead times for the product that this supply chain produces has fallen from 6 or 7 months to 3 months. This is a very clear indication of an improvement in a supply chain's agility and its ability to be customer responsive. Moreover this has been achieved without any stock outs and a cost reduction has been negotiated as recognition of the reduced operational and inventory holding costs in the supply chain.

VI. Conclusions

This paper has presented a case study on a groundbreaking supply chain management information system in the aerospace sector. It has shown how multi-tier integration, between three tiers in the supply chain, can occur via the use of new technological standards, namely Web Services. This technology allows data to be taken from disparate systems across a supply chain, consolidated in a web-based information system and then the results of these data feeds presented to parties from all three tiers. This data, namely supply, demand and inventory, can then be analysed and a collective decision made regarding how the supply chain should operate. These standards allow for the manipulation of what can be regarded as supply chain processes, without interfering with the underpinning systems and the complexity that this would involve. Our study shows that the evolution to this type of planning requires a supply chain mindset to be present. This is where variables across the supply chain are considered, not just those within the operators own organization. Moreover, to fully exploit the potential of this technology, attention should be paid to the integration of the marketing and logistics functions in the tier one organisation, as communication between these two entities is pivotal to this approach. We also noted an adherence to a set of rules or principles of behaviour when operating in this environment e.g. conversations between the OEM and the tier 2 supplier must not cover issues of prices. That was considered a proprietary discussion between the tier 1 and the tier 2 organization.

Significant organisational benefits attributed to this information system were observed. These include a shift from a reactive to a proactive supply chain management approach; improved levels of schedule adherence and an improved level of operational responsiveness, which is leading to a significant reduction in the supply chains lead time.

In summary, this paper has shown that going beyond dyadic supply chain relationships is being enabled by breakthroughs in new technologies, which in turn are enabling new levels of agility to be delivered and levels of customer responsiveness achieved.

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Building Co-Operative Supply Chain in Auto Parts Manufacturing Industry

Yong-Kyun Chung *, Se-Hyung Cho **, Seung-Chul Kim(Corresponding author) ***

* Div. of Econ. and Int. Trade, Kangwon National Univ, Korea, ykchung@kangwon.ac.kr,

** Dept of Business Administration, Konyang University, Korea, shcho@kytis.konyang.ac.kr,

*** School of Business, Hanyang University, Korea, sckim888@hanyang.ac.kr

Abstract: As competition becomes more intense, it is becoming increasingly important for a firm to build an efficient supply chain for its survival and prosperity. One way to build an efficient supply chain is to integrate the supply chain activities by the member firms of different levels on the supply chain by developing cooperative relationships between firms.

Many factors are involved in developing cooperative relationships between firms, and their effects need to be studied. This paper investigates what factors are critical to build a cooperative buyer-supplier relationship in auto parts manufacturing industry.

Data was collected from two groups of firms in Korean auto parts manufacturing industry, 1st-tier parts suppliers and 2nd-tier parts suppliers. Our study reveals that there are significant differences in the way of collaboration depending on the level of the relationships.

Keywords: SCM & E-logistics; Auto industry; Multi-echelon supply chain.

I. Introduction

Nowadays supply chain management is a very popular word for industry practitioners as well as academics. As competition becomes more intense, it is becoming increasingly important for a firm to build an efficient supply chain for its survival and prosperity. One way to build an efficient supply chain is to integrate the supply chain activities by the member firms of different levels on the supply chain by developing cooperative relationships between firms, which means extending supply chain integration into further down the levels of the industry structure.

For no other industry is this true than automobile manufacturing industry of which the structure is very complex with multiple levels of firms from auto manufacturers and parts suppliers to the suppliers of suppliers, etc. Many factors are involved in developing a cooperative buyer-supplier relationship between firms in auto manufacturing industry, and their effects need to be studied. Also, researches often overlook the relationships beyond auto manufacturers and the 1st-tier part suppliers.

This paper attempts to investigate the buyer-supplier relationships in the auto parts manufacturing industry by

trying to find out what factors are critical to build a cooperative buyer-supplier relationship, and whether there are any differences in the degree of collaboration between different levels of relationships, i.e., auto manufacturers and 1st-tier parts suppliers, and 1st-tier suppliers and 2nd-tier suppliers.

For this research, we are using the data collected from Korean auto parts manufacturers. Korean auto manufacturing industry is very sizable with a 5.8% of the world total production in 2002 (Korea Auto Industries Cooperation Association, 2003), and its exports to the world market is also increasing every year. The majority of Korean auto parts manufacturers is small to medium sized enterprises (SMEs), and thus are lagging behind in implementing supply chain management in their firms due to a lack of resource in financial, human, and technology area. Also, many of them are very dependent on the buyer firms in supply chain integration issues. Our research would provide useful insights into the current situation of the industry and also future directions for working toward mutually beneficial relationships among firms.

II. Literature Review

Many previous studies investigated the relationships between buyer firms and supplier firms, and found that both groups of firms will benefit more from the cooperative relationships than the competitive relationships. Table 1 contains some of the previous research that investigated various types of the buyer-supplier relationship and its impact on the firms.

In the 1980's, Japanese auto makers made an impressive progress in the US market with high quality cars, and it was considered that the high quality could be achieved by the cooperative relationships between Japanese auto makers and their suppliers. Nishiguchi and Brookfield (1997) examined and compared US and Japanese auto industry, and their findings attributed the Japanese auto makers' success to the cooperative buyer-supplier relationships. Maloni and Benton (1997) suggest that it is essential for a firm's survival to have cooperative relationships with their suppliers. Other studies also examined various types of buyer-supplier relationship and its impact on the firms' performance and the efficiency of their supply chain.

III. Research Methodology

III. 1 Hypotheses

The variables representing each factor of the model and the related previous studies are described in Table 2. Dependent variable is the degree of cooperation between firms which are auto manufacturers, 1st-tier parts suppliers, and 2nd-tier parts suppliers. Independent variables include information system related variables, firm's commitment to the relationships, JIT (Just-in-Time) environment, and bargaining power.

Table 1. Summary of previous studies.

Researcher	Content
Nishiguchi and Brookfield (1997)	Compared US and Japanese auto industry. Japanese auto industry has more cooperative buyer-supplier relationships.
Maloni and Benton (1997)	Emphasized the importance of the buyer-supplier cooperation.
Harwick (1997)	Cooperation with the supply chain partners for improving the supply chain efficiency.
Cooper (1993)	Reasons that firms form a supply chain (inventory reduction, improving service, etc.)
Lamming (1993)	Suggest a lean supply chain model in auto industry to understand the buyer and supplier relationship.
Han (1993); Fisher et al. (1994); Imne and Morris (1993)	The importance of buyer-supplier relationship for a firm's competitive advantage.
Shapiro (1985); Spekman (1988); Landeros and Monczka (1989); Burt (1989); Bensaou and Venkatraman (1995); Helper (1991); Helper and Sako (1995)	Investigate the various types of buyer-supplier relationship: competitive vs. cooperative open market negotiation vs. vertical integration integrated vs. structural
Smith et al. (1995);	Trust and cooperation between firms.
Landeros (1993);	Define the cooperative relationships

Figure 1 contains the research model showing the relationships between the tiers of firms in the supply chain, and hypotheses are constructed as below for each of the relationships indicated as H1 through H3.

H1: Collaboration between firms is positively related to the independent variables selected (information system, commitment, JIT environment, bargaining power).

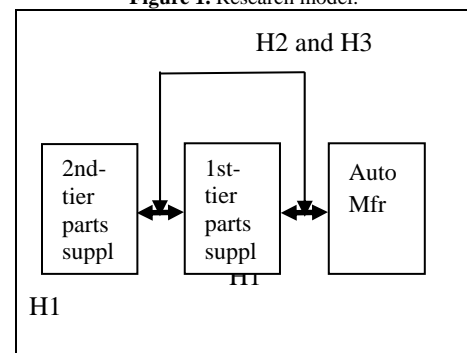
H2: The intensity of collaboration is different between the 1st-level relationship (auto manufacturer and 1st-tier parts suppliers) and the 2nd-level relationship (1st-tier and 2nd-tier parts suppliers).

H3: Important factors affecting collaboration are different between the 1st-level and the 2nd-level relationships.

Table 2. Description of the variables.

Variable	Name	Content
Independent	Information system	Informatization level Information exchange Information sharing
	Commitment	Technical cooperation Length of relationship
	JIT environment	JIT environment
	Bargaining power	Bargaining power on transaction condition
Dependent	Collaboration	Degree of cooperation

Figure 1. Research model.



III. 2 Data Collection

Data for this study was collected from auto parts manufacturers through survey in 2003-2004. The survey questionnaire consists of 35 questions. The survey was conducted by company visits and e-mails inviting managers to participate in the survey through the active server page on the web site. The respondents are the staff of the sales department in each company, and thus familiar with the relationships between their own company and their buyer company. A total of 69 companies participated in the survey, and 67 of them were used for this study after two were discarded due to incomplete responses. They were divided into two groups depending on their relationship with the

automobile manufacturers. 35 companies were the 1st-tier parts suppliers, and 32 companies were the 2nd-tier parts suppliers.

The survey questions are answered by 5-point Likert-type scale except those requiring single item answers. We used descriptive statistics, factor analysis, t-test, and regression to analyze the data. The summary of the results are presented in the tables.

IV. Analyses and Results

Tables 3 through 5 show the results of the tests to find out the relationship among the variables and to determine the acceptance of the hypotheses presented in the above.

IV.1 Test of Hypothesis 1

We used simple and multiple regression analyses to find out what variables affect the inter-firm collaboration level and the results are presented in Table 3. In simple regressions, each independent variable was individually tested, and in a multiple regression analysis all the independent variables were tested with the dependent variable. Except the JIT environment, the effect of all the other variables turns out to be significant. Therefore, information sharing, commitment and bargaining power are all important for developing and improving inter-firm collaboration. However, a simple delivery of parts on time, i.e. JIT implementation alone, may not be enough to enhance the inter-firm collaboration.

Table 3. Test of Hypothesis 1 (simple regression).

Variables	b	t	p-value
Information sharing	0.491	4.541	0.000
Commitment	0.686	7.610	0.000
JIT environment	0.097	0.784	0.436
Bargaining power	0.502	4.674	0.000

IV.2 Test of Hypothesis 2

We used t-test to determine whether there is difference in the degree of inter-firm collaboration between the 1st-level relationship (auto manufacturer and 1st-tier parts suppliers) and the 2nd-level relationship (1st-tier and 2nd-tier parts suppliers). Table 4 shows the results. The difference turned out to be significant at $\alpha = 0.05$. Thus, firms tend to have different degree of inter-firm collaboration depending on which level a firm belongs to in a multi-echelon supply chain. The suppliers in the first level seems to have a closer relationship with auto manufacturers than the relationship between the first level suppliers and the second level suppliers. A possible reason for this may be that the firms' infrastructure such as information system is more compatible in the 1st-level relationships than the 2nd-level.

Table 4. Test of Hypothesis 2 (t-test).

group	N	mean	s.d.
1st-level relationship	35	2.83	0.776
2nd-level relationship	32	2.38	0.875
t = 2.248, df = 65, p-value = 0.028			

IV.3 Test of Hypothesis 3

We conducted simple regressions separately for the 1st-level and 2nd-level relationships and compared the results with each other. As shown in Table 5, the important variables affecting the inter-firm collaboration are not different between the two levels. For both cases, information sharing, commitment, and bargaining power turned out to be important to develop inter-firm collaboration.

Table 5. Test of Hypothesis 3 (simple regression).

Variables	1st-level	2nd-level
Information sharing	Significant (0.081)	Significant (0.002)
Information sharing	Significant (0.081)	Significant (0.002)
Commitment	Significant (0.000)	Significant (0.003)
JIT environment	Not (0.322)	Not (0.659)
Bargaining power	Significant (0.021)	Significant (0.001)

V. Conclusion

We have found several factors important for inter-firm collaboration. Specifically, important factors include information sharing, commitment, and bargaining power. JIT environment was not found to be essential for developing inter-firm collaboration. This results confirms the findings by Helper(1991) that JIT implementation was not necessarily an indication of a cooperative relationship. Secondly, the level of collaboration increased as the relationships were closer to the auto manufacturer. That is, the 1st-level relationship has a higher degree of inter-firm collaboration than the 2nd-level relationship. Lastly, there were no difference in the factors affecting inter-firm collaboration between the two levels. In both levels of relationships, the three factors of information sharing, commitment, and bargaining power had a significant impact on the inter-firm collaboration.

Summing up the results, firms need to develop a proper communication system for information sharing, and a trustworthy relationship through commitment such as a long-term contract, and allow suppliers with a certain degree of bargaining power for determining delivery, price, payment method, etc.

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Structures and Technologies for Stepwise Implementation of Adaptive Supply Chain

Reggie Davidrajuh *, Velauthapillai Dhayalan **

* Electrical & Computer Engineering, University of Stavanger, Norway, Reggie.Davidrajuh@uis.no

** Computer Science, Bergen University College, Norway, vdh@hib.no

Abstract: Falling margins, globalization, and accelerating innovation cycles are forcing businesses to switch from traditional (linear and sequential) supply chains to adaptive supply chain that possess the flexibility needed to respond to the environment in real time. As adaptive supply chains are large and complex, they are built step-wise using structures; structures are a well-defined portion of the system, with carefully defined inputs, outputs, and functions. In addition, the structures must follow common standards, based on common architecture for seamless integration with the rest of the components. In this paper, first, we present the problem of implementing a new iterative-based distribution chain that has four distinctive modules. Second, we present a survey of commonly used structures in some of the well-known modern supply chain solutions (e.g. stages in SAP, layers in HP Real Time Supply Chain, modules in i2 Six/IBM) is presented. Third, by going through the structures, we present an optimal solution for implementation of the adaptive distribution chain.

Keywords: Supply chain, adaptive system, structures in design and development.

I. Introduction

Supply chain efficiency is one of the fundamental issues for the survival of enterprises in today's hyper-competitive business environment. In addition, in the world today, the amount of uncertainty that enterprises are facing (e.g. terrorist attacks, labor strikes, other sources of vulnerabilities such as sabotage and weather-related issues), makes supply chains much more vulnerable. Hence, enterprises implement *adaptive* supply chain to withstand unpredictable shocks, and to respond to the environment in real time without compromising on operational and financial efficiencies.

The characteristic of an adaptive supply chain is to have the highest visibility, greatest velocity, and best ability to manage variability [3][4]. Visibility is the ability of all the collaborating partners sees the vital data; velocity is the speed of information flow across the supply chain; variability is the ability to withstand unpredictable events. Achieving these three characteristics is not easy considering the complexity and diversity of the applications collaborating partners are using. Thus, most supply chain solutions develop supply chain step-wise, using well-defined structures.

easier to acquire, there are often too a large number of available features. For example, in the cases of book or movie recommendation, there can be a large number of keyword features of the products from their themes, genres, and text-based description of the products. These features may directly affect the choice of shoppers, and thus, are often used as key features of recommendation, especially for cultural and content-focused products. This problem may lead to inefficiency or ineffectiveness of recommendation. In terms of efficiency, inaccurate or irrelevant keywords may require huge system memory or lead to increased processing time; in terms of effectiveness, there can be often inaccurate or irrelevant words that may damage the recommendation quality. Consequently, it has been recognized to be very important to extract a more meaningful subset of features that can contribute better to recommendation performance [1, 5, 8].

In this study, we utilized a data set that was constructed from a virtual shopping experiment in an Internet book shopping mall in Korea to find out how feature reduction techniques that have been widely used in pattern matching or information retrieval can be applied to the recommendation problem. We used a Korean lexical analyzer to extract features and use the features to construct user and product profiles. The Term Frequency (TF), Inverse Document Frequency (IDF), TFIDF, mutual information, and Singular Value Decomposition (SVD) methods were chosen and adapted for the experiment.

The remaining part of the paper is organized as follows. In the second section, we provide a brief review of feature selection methods from other disciplines. In the third section, we explain the experiment procedure and present the results of the analysis. The fourth section concludes with discussion and further research issues.

I. 1 Problem definition

Figure-1 shows an iterative approach for developing agile distribution chain, for details see [1]. The iterative approach consists of two parts: the first part is to determine the strategic model and the second part is to determine the tactical model. The strategic model gets the initial values for the configuration of the distribution chain (e.g. number of distributors, location of distributors, etc.) from the ongoing or past collaborations of the virtual enterprise. Mixed Integer Programming (MIP) is used for determining the strategic model. In the tactical model, two issues are mainly considered: identifying routes for vehicles by genetic algorithm, and determining parameters for inventory control by probability theory.

After determining tactical model, the newly calculated

operation related parameters (e.g. the unit product delivering cost, average inventory level, etc.) are input again into the strategic model in order to re-optimize the configuration of the distribution chain. Thus, this is a complex to system to build; we need a step-wise approach to develop this supply chain using well-defined structures. The main purpose of this paper is to survey the structures in modern supply chain solutions, so that an optimal structure could be found for step-wise implementation of the adaptive distribution chain shown in figure-1. Since there are numerous business solutions available for developing adaptive supply chain, this paper surveys only the few well-known ones.

In this paper: a survey on the structures for step-wise development of modern adaptive supply chain solutions is given in section-2 (“literature review”). From this survey, an optimal structure for step-wise development of the adaptive distribution chain is given in section-3 (“Implementing Adaptive Distribution Chain”). Finally, section-4 presents some concluding remarks.

II. Literature Review

The structures that are used to develop supply chain step-wise should be a well-defined portion of the system, with carefully defined inputs, outputs, and functions [5]. In addition, the structures must follow common standards, based on common architecture for seamless integration with the rest of the components. Commonly used structures in supply chain development are:

- Stages [4],
- Layers [2], and
- Modules [3]

The following section presents some supply chain solutions and the structures used by them.

II. 1 SAP: Development in Stages

The basic design methodology behind SAP’s adaptive supply chain is to map the three key process enablers (such as management of visibility, management of velocity, and

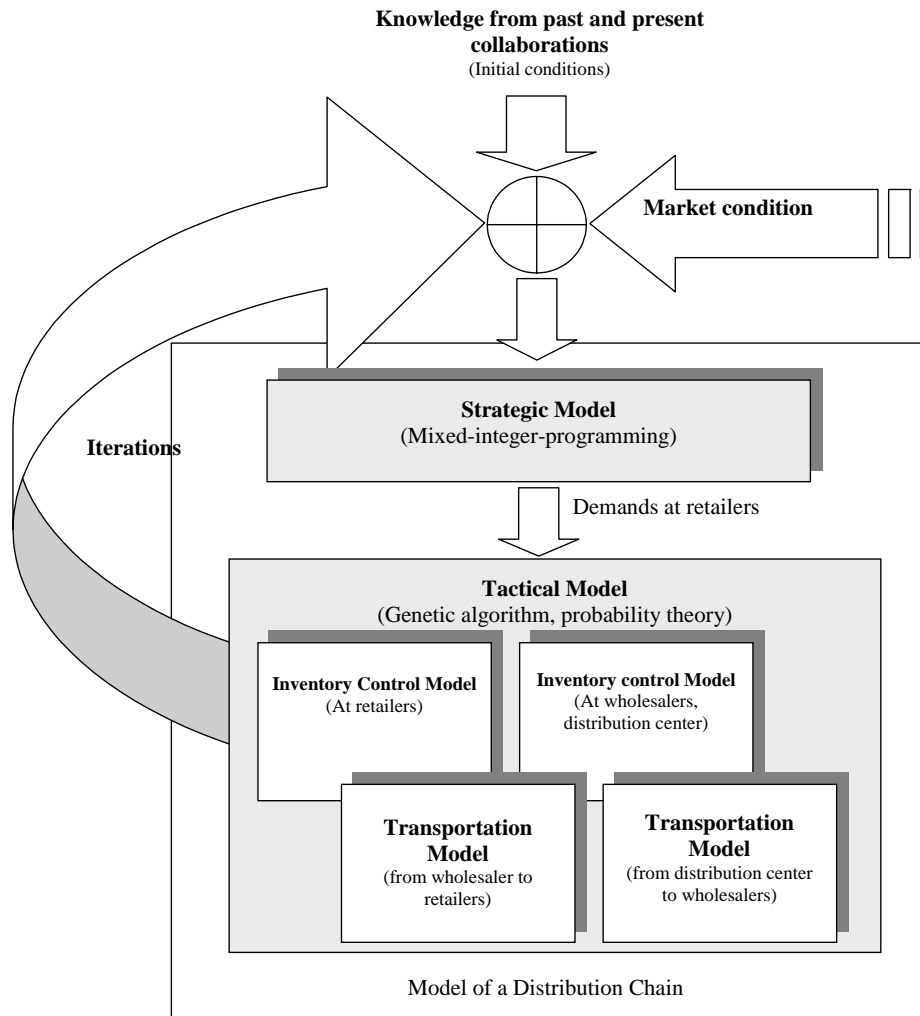


Figure-4: The iterative approach for adaptive distribution chain design

management of variability) to the three key information enablers (such as quality of information, timeliness of information, and depth of information). The mapping is strengthened in three stages such as integrated, collaborative, and adaptive [4].

The three mappings of process enablers to information enablers: Visibility of quality information is the fundamental building block for adaptive supply chain. This is because visibility to both intra- and inter-organizational information is critical for rapid response to changing market conditions. For example, information visibility of orders, plans, supplies, inventory, and shipments is key to both successfully coordinating events across the supply chain and for monitoring and taking proactive actions across the chain. Thus, the first mapping along the adaptive supply chain development is the mapping of visibility on information quality.

After achieving visibility of quality information, the next mapping is to increase the velocity of response by accessing and distributing information rapidly across the supply chain, as velocity of response is the key differentiator in business performance.

As depth of information will allow enterprises to better manage unpredictability (variability) introduced to the supply chain, mapping of these two enablers is the final aspect of developing adaptive supply chain for a dynamic business.

The three stages: To create an adaptive supply chain, SAP make sure that the enterprise advance from traditional supply chain to adaptive supply chain through three specific stages; the three stages are integrated, collaborative, and adaptive [4].

The integrated stage is the first step towards formation of adaptive supply chain where improvement of the operational visibility and efficiency is accomplished, by integrating diverse applications run by the collaborating partners. The fundamental concept behind integrated stage is that the extent of integration directly determines the degree of visibility and that visibility is the basic building block for an adaptive supply chain. In the second stage known as collaborative stage, the ability of the supply chain to exchange real time information is improved; in other words, the velocity of information is improved. The final stage is the adaptive stage, which is concerned of managing variability.

II.2 Hewlett-Packard: The Layered Approach

Hewlett-Packard (HP) emphasizes real time application integration for developing adaptive supply chain (or in HP terminology - the real time supply chain (RTSC) [2]. The RTSC is organized around three layers:

1. The foundation layer: In this layer, the data management component creates a single, consolidated and cleansed repository of key supply chain data from all supply chain applications across the enterprise
2. The middle layer: In this layer, supply chain business

applications component integrates existing supply chain applications and provides them with a single, real time view of the entire supply chain.

3. The upper layer: In this layer, supply chain consulting and integration components provide the services and best practices from HP and its partners

In summary, HP develops adaptive supply chain in three stages: data integration, application integration, and finally service integration.

II.3 i2: Modular Approach

i2 Six uses a modular approach for developing adaptive supply chain. The modules can be implemented independently to suit enterprise's specific needs and pressing business challenges first, enabling gradual implementation. The six modules for developing adaptive supply chain are [3]:

1. Production optimization (meeting the demand in real time),
2. Spend optimization (supplier relationship management),
3. Revenues and Profit optimization (Demand management, customer relationship management),
4. Fulfillment optimization (real time planning, build-to-order, inventory management),
5. Logistics optimization, and
6. Business optimization (Business and process definitions, supply chain analysis)

All these six modules are based on common architecture, common infrastructure, and common parameter-based tools, allowing independent implementations and addition of new functionality.

III. Implementing Adaptive Distribution Chain

Developing supply chain in stages allows an enterprise to take the time it needed; the time taken for an enterprise to implement supply chain solutions vary depending on its degree of technology mastery, the process maturity, and the characteristics of the business. The main advantage of using stages is that each stage provides a functional (it could be crude yet functional) system. The main disadvantage of the stages is that if a new stage is planned from the current stage, then it is possible that the current stage could not support evolution of the new stage from it. Then, we may have to go previous stages to make the necessary changes (meaning, rewriting code) so that current stage become robust enough to support development of a new stage from it. Hence, whenever a new stage is planned, one should anticipate drilling through several previous stages.

In developing supply chain in layers, the supply chain is broken into a number of layers (levels). The bottom layer (layer 0) is the common integrating infrastructure that connects supply chain with the communication platform; the

bottom layer is the most primitive layer offering only the basic hardware interface/communication/operating systems services. The highest layer (layer N) is the application layer interacting with the user and the rest of the applications. The main advantage of the layered approach is simplicity of construction and debugging [5]. The main disadvantage of layered approach is that a group of layers do not provide a fully functioning system; we have to have all the layers (from layer 0 to layer N) to make a functioning system offering some services to the user.

Modules give the freedom of selecting and implementing only those modules with specific functions that are needed to take care of pressing business challenges. Though modular implementation resembles layered approach, modules are more flexible than the layered system in the sense that any module can call any other module (whereas a layer can use only lower-level layers) and that modules can be implemented in any order (whereas lower-level layers must be implemented first).

None of the structures discussed above – stages, layers, or modules are adequate to develop adaptive distribution chain. The reason is that, all these structures are applicable for developing desktop applications only. However, adaptive supply or distribution chain is inherently distributed. This means, the module making strategic calculations (see figure-1) should be running on a machine at the head quarters of an enterprise, the transportation modules may be running on the computers at distributors and wholesalers, and the inventory control modules at retailers and wholesalers. This means, one expects that all the 5 modules (one strategic and four tactical) run on computers located on geographically distributed places. We need Web Services to glue the

modules together. Web services is cheap, efficient, and based on open standards; there are numerous books, articles and case studies on Web Services; see [6].

IV. Concluding Remarks

This paper surveys the structures in some of the well-known modern adaptive supply chain solutions. The structures used in those supply chain solutions were stages (e.g. SAP), layers (e.g. HP), and modules (e.g. i2). Though a supply chain solution may choose any structure (stage, layer, module, iteration, etc.) as the basic building block to ease supply chain development, it must aim to provide the basic characteristic of adaptive supply chain – namely visibility, velocity, and variability. To build an adaptive distribution chain, which is inherently distributed, the above-mentioned structures are not adequate enough. We need Web services to glue together the different modules that are running in geographically distributed places.

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A Multi-Agent Approach Towards Collaborative Supply Chain Management

Xin Li*, Sim Kim Lau**

School of Information Systems, Faculty of Commerce,
University of Wollongong, Wollongong, NSW 2522, Australia

* xl14@uow.edu.au

** lixinism@hotmail.com

Abstract: Supply chain collaboration has become a critical success factor for supply chain management and effectively improves the performance of organizations in various industries. Supply chain collaboration builds on information sharing, collaborative planning and execution. Information technology is an important enabler of collaborative supply chain management. Many information systems have been developed for supply chain management from legacy systems and enterprise resource planning (ERP) into the newly developed advanced planning and scheduling system (APS) and e-commerce solutions. However, these systems do not provide sufficient support to achieve collaborative supply chain. Recently, intelligent agent technology and multi-agent system (MAS) have received a great potential in supporting transparency in information flows of business networks and modeling of the dynamic supply chain for collaborative supply chain planning and execution. This paper explores the similarities between multi-agent system and supply chain system to justify the use of multi-agent technology as an appropriate approach to support supply chain collaboration. In addition, the framework of the multi-agent-based collaborative supply chain management system will be presented.

Keywords: Supply Chain Management; Supply Chain Collaboration; Agent Technology and Multi-Agent System.

I. Introduction

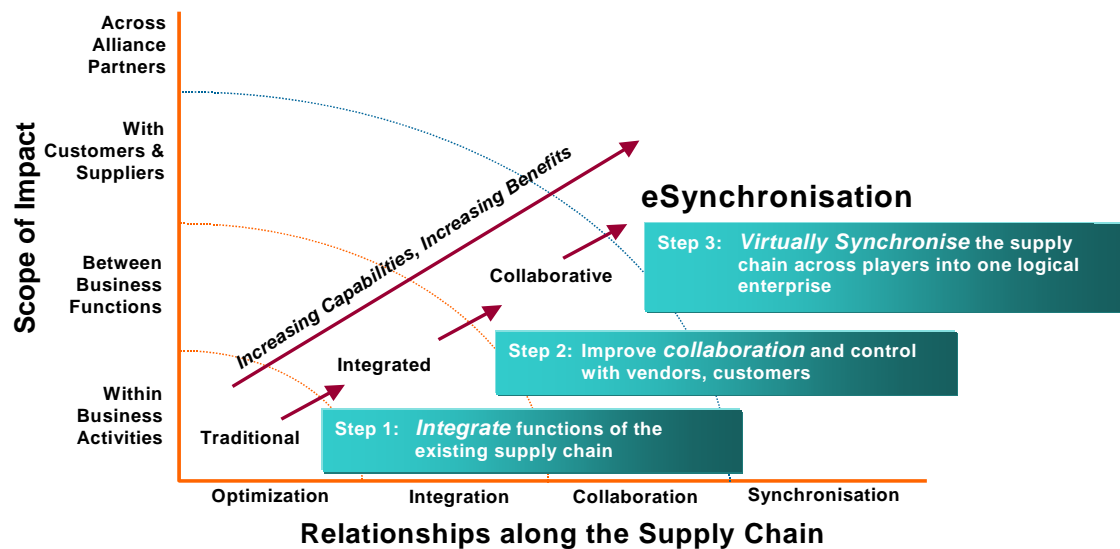
In today's competitive business environment industry is recognizing the importance of efficient and effective supply chain management. Supply Chain can be viewed as a network of facilities (that connected from the ultimate suppliers to the ultimate customers) and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers. These autonomous or semiautonomous business entities that perform all processes associated with the flow and transformation of goods and services from the raw material stage, through to the end user, as well as the associated information flows (Chorpa & Meindl 2004). According to Simchi-Levi (2003), the objective of supply chain management is to produce and

distribute merchandise at the right quantities, to the right locations, at the right time, in order to minimize systemwide costs while satisfying service level requirements. To realize the objective, the successful supply chain management requires effective support of advanced information technology and information system. Many information systems have been developed for the SCM from enterprise resource planning (ERP) into the newly developed advanced planning and scheduling system (APS) and e-commerce solutions. However, the capability of current information systems to support collaborative planning and control in the supply chain systemwide level is limited due to the complexity and dynamics of the supply chain in today's globalized business environment. Recently, agent-based system and technology have been applied as a new paradigm for conceptualizing, designing and implementing the software system, which offers the potential to overcome many limitations of current information systems for the SCM.

The aim of this paper to investigate the appropriateness of multi-agent based technology to support collaborative supply chain management. The remainder of this paper is organized as follows. First, issues regarding supply chain collaboration will be discussed in section two. Then, the roles and limitation of current information systems in the SCM will be discussed in section three. In section four, the characteristics of agent technology will be elucidated and its similarities between the supply chain system and multi-agent system will be analyzed. Finally, the framework of multi-agent-based collaborative supply chain management system will be presented.

II. Supply Chain Collaboration

Supply chain collaboration has become cornerstone of high performance in supply chain. According to Quinn (2001), it is believed that whether or not a company can effectively collaborate with the upstream and downstream supply chain participants has become a core business competency. Supply chain collaboration builds on two basic paradigms: sharing information, collaborative planning (Simchi-Levi 2001, Gattorna 2000, Bowersox, et al. 2002). Information sharing is the basic of collaboration in which supply chain partners share information about demand, inventory level, and promotional activities. It is recognized that only sharing information on historical or accurate sale data is not enough. Of greater importance is to share strategic information about



Source: Accenture

future activities to facilitate collaboration. Collaborative planning is the main content of supply chain collaboration. Actually, collaboration is one step along the supply chain development path for a company. According to Gattorna (2003), the adoption of collaboration tends to be evolutionary. As shown in Figure 1, it evolves from the integration of internal enterprise operation to the enterprise extension - collaborative planning with upstream suppliers & downstream customers and then extend to the supply chain system level.

As shown in the figure 1, the final stage of the evolution towards collaborative supply chain planning is the development of a network of supply chain partners who work together for mutual benefits. This network would encompass the extend supply chain and include outsourced service providers such as 3PLs and contract equipment manufacturers into an intelligent supply chain system. The competition in this brave new world has transformed from company versus company to supply chain versus supply chain. Due to the evolution of supply chain collaboration, the supply chain management is no longer focusing on inter-entity level. The philosophy of supply chain decision-making has changed to system level. Nowadays SC consists of many independent entities that are usually separated geographically due to globalization and increasing outsourcing activities. Each entity has its own operational strategies, and business decision mechanism under different constraints, i.e., they are autonomous in nature. Since SCM integrates the issues of multiple stage production and multiple stage distribution systemwide planning, the network is a complicated system.

III. Information Systems in Supply Chain Management

Collaborative supply chain such as information sharing,

collaborative planning and execution between organizations require effective support through advanced information technology. Information technology, as an important enabler of effective supply chain management, consists of tools used to collect, organize, access, share and analyze the information, and act on it to improve the performance of the supply chain. Over the last decade, various information systems have been developed to support the SCM from early less sophisticated legacy system to the ERP systems, then to the more advanced SCM systems such as the APS. However, inter-organizational coordination and collaboration increasingly require more effective information technology support and are usually not covered sufficiently by traditional information systems such as the legacy systems, ERPs and APSs (Yuan et al. 2001, Hillegersberg et al. 2004). More often than not, current information systems that support the components in the supply chain process are developed by different vendors and are generally disconnected. Typically, these systems have evolved over the years based on various local and company-wide requirements and were rarely integrated (Erasala et al. 2003). Disparate IT systems and lack of integration and collaboration make it impossible for many corporations to support the required responsiveness and capability demanded by customers (Puckridge & Woolsey 2003). Although the more recently introduced E-markets and E-hubs also aim to support inter-organizational coordination, their success has been limited. They mainly provide the platform of connectivity, information exchange and support for trading between companies in a network.

Legacy system:

The problem of integrating with legacy systems was viewed as one of the major challenge and inhibitors to new IT development (Erasala et al. 2003). Legacy systems evolved as functional solutions using mainframe or minicomputers. In the past, mainframe-based legacy systems were applied to

support transactional processes within one specific function such as order entry, inventory control and accounting. These transactional processing systems were isolated and implemented with incompatible hardware and software. These system lacked integration across functional areas even within a single company (Yuan et al. 2001). Nowadays, in spite of extensive investment in state of the art application software, many firms are still dependent on legacy systems for mission-critical applications. (Erasala et al. 2003)

ERP:

The ERP system facilitates the flow of transactional data in a company relating to manufacturing, logistics, finance, sales and human resources. It mainly focuses on providing the visibility of information within the enterprise and the automation of business processes. It offers the promise of homogeneous, transactional data that can facilitate integration of functional areas within the enterprise at the operational level (Taylor 2004, Simchi-Levi et al. 2003). The ERP mainly focuses on collecting, organizing, accessing, and sharing the information within the enterprises, rather than focusing on analyzing data and information to make decision. Although some ERP vendors have begun to address this issue and add more planning modules, it remains focusing on scheduling individual production facilities and not the entire networks of facilities operating in collaboration. The ERP offers two main benefits that do not exist in non-integrated departmental systems: an enterprise-wide view of business encompasses all functions and departments; and an enterprise-wide database, in which all business transactions are recorded, processed, accessed, monitored and reported (Umble et al. 2003). Due to the fact that the information processes across functional areas within the enterprise are now integrated, it provides a much better base for inter-enterprise cooperation. However, since the major focuses of ERP are limited to intra-enterprise operation, these systems lack support for inter-enterprise collaboration in the SCM (Yuan et al. 2001).

APS:

Faster and easier access to transactional data does not automatically leads to better decision-making and competitive edge in the SCM (Shaprio, 2001). The APS system, such as production planning and scheduling, forecasting, master planning and supply chain network optimization systems, is a class of software for Decision Support System (DSS) in supply chains. It provides analytical applications to optimize the use of supply, manufacturing, distribution, and transportation resources to match the demand (Bansal 2003). It is developed and applied for evaluating and disseminating decision based on models constructed from supply chain decision databases (Shaprio 2001). APS are based on the principles of hierarchical planning and make extensive use of solution approaches known as mathematical programming to find the optimal solution for a given set of objectives. These objectives can include minimizing cost, meeting customer-

service targets, accelerating the flow of inventory, or any other combination of performance targets. It can be used to tackle strategic, tactical and day-to-day operational problems (Simchi-Levi et al. 2003). Although APS system has been a powerful tool for effective supply chain planning, today it faces a main challenge from supply chain collaboration and decentralization. Due to the centralistic view of supply chain decision database and hierarchical planning underling today's APS, it might be suitable in an intra-organizational SC or a focal inter-organizational SC but not in such a complex supply chain network (Chan, F.T.S. & Chan, H.K. 2005). Developing an integrated supply chain planning information system based on current methods may requires that all systems to be re-developed into a monolithic integrated system capable of handling all foreseeable scenarios for planning and execution (Chan, F.T.S. & Chan, H.K. 2005). However, this is regarded as not feasible due to the high development and maintenance cost, not to mention the inflexibility of such a system. Furthermore, if partners are reluctant to share their data and to feed it into a central supply chain data-base while insisting on their own planning domain, modeling SC-wide flows by a single APS is no longer possible.

E-commerce:

E-commerce is promoted by the rapid growth of Internet and web technology, which has provided a great potential for networking and interaction between business and consumer (B2C) and between business partners (B2B). It encompasses the electronic buying and selling transactions between organizations, named as E-procurement (Neef 2001, Swaminathan & Tayur 2003). It can be applied to set up E-marketplaces and E-hubs for online bidding and auctions for business competition (Neef 2001, Emiliani 2000, Swaminathan & Tayur 2003). Moreover, E-commerce offers not only the solutions required for inter-company transactions but also the standards that will facilitate connection and communication among corporations (Berger 2003). However, in spite of the fact that E-commerce has improved the supply chain visibility through information sharing and the coordination between buyers and sellers through the Internet, the new technology is still needed to support for high-level knowledge sharing (not just transaction data) and facilitate more robust collaboration (not just simple buy and sell models) (Yuan, et al., 2001).

In summary it is clear that inter-organizational coordination and collaboration were not sufficiently achieved by traditional information systems. The successful supply chain collaboration requires more effective information technology supports. Recently, intelligent agent technology and multi-agent systems have shown great promise in supporting collaboration in supply chain management, particularly in supporting transparency in information flows and modeling of the dynamic supply chain for collaborative supply chain planning (Iskanian et al. 2004, Xue et al. 2005). In addition, intelligent agent technology offers the potential to overcome many limitations

of current supply chain technologies and offers new means and tools for supply chain collaboration (Gutpa et al. 2001, Frey et al. 2003).

IV. Supporting Supply Chain Collaboration by Using Agent Technology

There is no universally accepted definition of the term of agent. According to Wooldridge and Jennings (1995), an agent is a self-contained software program capable of controlling its own decision making and acting based on its perception of its environment, in order to gain one or more goals. The agent has the following main behaviour attributes: autonomous, cooperative (social), reactive, proactive, and learning (Wooldridge & Jennings, 1995). Being autonomous means that agent can act without intervention by other entities (humans or computer systems), and exercising control over one's own action/algorithms. Agents can interact with other agents (or possibly humans) via some kind of agent communication language (social). To be reactive means that agents can perceive the environment around itself and are able to respond in a timely fashion to changes in the environment (reactive). In addition, agents do not simply act in response to the environment but are parts of a more complex goal-oriented behaviour (proactive). Also, agents can change their behaviour based on their previous experience (learning).

A multi-agent system is one that consists of a number of agents that take specific roles and interact with one-another to solve problems that are beyond the capabilities or knowledge of any individual agent (Wooldridge 2002). These interactions can vary from simple information interchanges, to request for particular actions, and on to cooperation, coordination and negotiation in order to manage interdependent activities (Jennings 2000). The interaction and coordination are the core process of a multi-agent system (Lee et al. 2004). According to Jennings & Wooldridge (2002), agent technology and multi-agent system can be used to develop highly complex systems. Paranak et al. (1998, P.24) claimed, "...agent-based modelling is most appropriate for domains characterized by a high degree of localization and distribution and dominated by discrete decision..." Supply chain system is a large-scale complex system. Decentralisation, collaboration and intelligence are its essential characteristics. The greater details of the similarities of the nature of these two systems are shown as follows:

Firstly, individual agent has incomplete information, knowledge or capabilities to solve the problem and thus has a limited viewpoint. Data, information and knowledge are in distributed agents (Jennings, et al. 1998). In addition, different agents also have the different core functionalities that play the different roles in the multi-agent systems. MAS can solve problems that are beyond the capabilities or knowledge of any individual agent (Wooldridge 2002). The supply chain network has the same characteristic. A supply

chain consists of multiple autonomous participants that play the specific roles along the supply chain (Chopra & Meindl 2004). Each supply chain participant has its own resource, expertise, capabilities and capacities. It performs certain tasks and roles in making the products that conform to customer requirements (Simchi-Levi 2003). Different supply chain participants have different core competency. An individual supply chain participant cannot solve all the tasks in the supply chain.

Secondly, there is no system global control in a multi-agent system. A multi-agent system consists of different autonomous agents can play different roles and functions in the system (Jennings & Wooldridge 2002). Each agent responds on its own to monitor changing environment, proactive to take self-initiated action, and behave socially to interact and communicate with other agents. In most cases there is no single authority in the supply chain. Usually, the different functions belong to different companies in a supply chain. A single company cannot govern or control the whole supply chain performance. The supply chain participants are autonomous or semi-autonomous. They have the authority to implement different supply chain strategies and take certain action in response to the changing markets.

The third similar characteristic is collaboration and coordination. In fact coordination is the core process of the multi-agent system (Lee et al. 2004). In a multi-agent system, each agent attempts to maximize its own utility while cooperating with other agents through negotiation and cooperation to achieve their overall goal (Jennings 2000). In a supply chain, different supply chain participants may have different and conflicting objectives (Chopra & Meindl 2004, Simchi-Levi et al. 2003). To optimize performance and achieve the whole system optimization, the supply chain participants must work in a coordinated and collaborative manner (Lau et al. 2004). In the collaborative supply chain, decision-making is through multi-party negotiation and coordination in order to minimize the total cost and maximize the total supply chain profitability while meeting the customers' needs.

Finally, the structure of the multi-agent system is re-configurable. It supports handling of dynamics and is capable of making a quick response to the changing environment (Persson & Davidsson 2005). Multi-agent system is flexible. Agents in the multi-agent system can be organized according to different control and connection structure and agents can be created or discarded. In addition agents can delegate its task to other agents and coordinate other agents to form a higher-level system (Jennings 2001). The supply chain is a dynamic system and the relationship among different participants can evolve over time (Simchi-Levi et al. 2003). The supply chain participants may join or quit the supply chain. Therefore, the structure of the supply chain is flexible and is responsive to the changing environment. The structure of the supply chain can be organized differently when implementing different strategies according to different environment and business goals. Also, tasks in supply chain can be decomposed into subtasks, or

multiple tasks can be composed to form a large task.

Therefore, it can be seen that supply chain systems has many similarities with the characteristics of Multi-agent system. Thus it is reasonable to apply the multi-agent system to model the supply chain network and process, and to implement supply chain management applications. In fact, multi-agent systems involving multiple agents with distributed knowledge and information are well suited for analysing coordination problems in supply chain management (Bond & Gasser 1988).

V. Framework for Agent-Based Collaborative Supply Chain Management System

In this section, we will present a framework of agent-based supply chain coordination and collaboration. The supply chain coordination and collaboration is analyzed in the context of a typical multi-national corporation scenario. The proposed framework focuses on the coordination of manufacturing and distribution functions. The scenario consists of several manufacturers, distributors, suppliers and logistics service providers (see Figure 2).

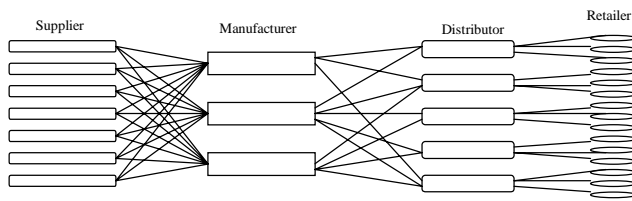


Figure 2: Supply chain network

In the framework of a multi-agent based collaborative supply chain management system, there are several agents involved: function agent, coordination agents, communication agent, and monitoring agent (Shown in figure 3). Coordination agents, communication agent and monitoring agent are designed to accomplish the manufacturing and distributing tasks in the multi-national enterprise together with existing planning and execution software (function agent). We will discuss the roles and functions of each of these agents in the proposed supply chain coordination system.

1) Function agent: Function agent is a set of existing and separate application software that are used by the distributors, manufacturers as well as by the logistics service providers. These application software are utilized in different part of planning, scheduling, and execution processes such as capacity analysis software, ERP, manufacturing execution system forecast software and so on.

2) Coordination agent: Coordination agent is designed with specified expertise, knowledge and coordination mechanism to coordinate the activities among agents in order to minimize enterprise-wide cost or maximize profitability of the whole supply chain system. Coordination agent may link to the communication agent, monitoring agent and function agent to get the necessary information.

The coordination agent is further classified into distribution coordination agent, manufacturer coordination agent and transporter coordination agent (showed in figure 4).

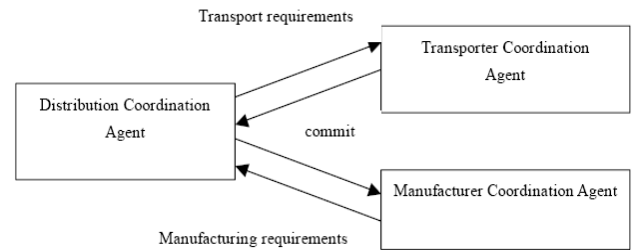


Figure 4: Agent-based supply chain coordination

a) Distribution coordination agent: Distribution coordination agent aggregates data and information from the distributors in different areas and perform distribution requirements computation. Then the distribution requirement plan can be established. It consists of four parameters, namely type, quantity, price and due date. The “type” parameter is the various kinds of products for manufacturing and transportation. The “price” parameter is the summation of all the prices of various products ordered by retailers. The “due date” parameter refers to the final date when the different distributors can receive the products and the “quantity” parameter is the desired quantity of each type of products. In addition, the distribution coordination agent can determine which “type” of products can be produced by the specific manufacturer, or by several manufacturers according to historical data and knowledge. Then, the distribution coordination agent transfers the “due date” of the “type” of the products into total “lead time” (“lead time” for manufacturers and “lead time” for transporters). Furthermore, the distribution coordination agent will coordinate with the transporters agent and the manufacturers to reach a feasible and optimized global supply chain solution. Figure 5 shows the functions of the distribution coordination agent.

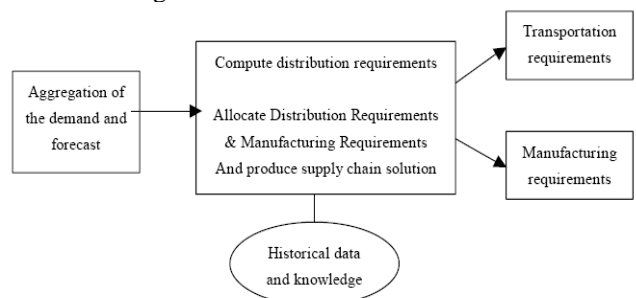


Figure 5: Distribution coordination agent

b) Transporter coordination agent: Transporters offer pickup and delivery service from different manufacturers to destination terminals or distributors. The operation decisions facing a transporter agent are: to select the right mode or modes of transportation based on costs and lead-time and to consolidate consignment for economic of scale. The transporter agent receives the transportation requirement and

agents, which facilitate the communication among agents, can select necessary information and share the information in the Multi-agent system. In this way, it can facilitate the information sharing among the supply chain participants and improving the visibility of the supply chain network. The proposed framework wrap the current exist systems such as legacy, ERP, and APS, etc into the function agents and connect these function agents with coordination agents through certain coordination mechanism to reach the system optimization. In addition, in the proposed framework, the monitoring agents monitor the real-time supply chain performance and inform related agents and decision makers when an emergence event occurs, then the related agents and the coordination agents will work together to amend the plan and inform the decision maker or automatically execute it. The paper presented here represents only the first step of our effort toward agent-based collaborative supply chain planning and execution. Further research and experiments are needed to extend the current work to address its shortcomings and design the completed model based on proposed framework and a detailed supply chain scenario.

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E-Connectivity as an Enabler for Dynamically Networked Supply Chains – Exploratory Research Findings

Robert Ogulin *, Willem Selen **
 Macquarie Graduate School of Management,
 Macquarie University, NSW 2109, Australia
 * robert.ogulin@lucis.com.au
 ** Tel: 61 2 9850 8984 Fax: 61 2 9850 9019
willem.selen@mgs.edu.au

Abstract: Dynamic markets require that supply chain partners work together in a timely and efficient manner. This paper introduces e-Connectivity, a construct describing how technology and process standards enable cross-company collaboration amongst partners in the networked supply chain. The paper highlights the collaborative and often short-term relationships where partners coordinate their mutual capabilities to address a transitory, but important, business opportunity in order to achieve collectively beneficial outcomes.

Through a literature review and exploratory interviews, the paper proposes and defines the construct of the dynamically networked supply chain. It then introduces how information technology and related processes enable dynamic collaborative practices in the supply chain. Subsequently, e-Connectivity is discussed as a key success factor in the development and deployment of informally networked supply chains.

Further empirical validation and testing may reveal that informal coordination in networked supply chains, enabled by eBusiness, is an important capability that impacts the operational effectiveness and competitive advantage of a firm.

I. Introduction

Collaboration between firms is a powerful source of competitive advantage, calling for efficient ways to integrate relationships in the supply chain, including the development and maintenance of information, physical and financial flows. An operating system is said to be superior to that of a competitor if it responds better to market opportunities, and as such secures the long-term viability of the firm. This paper develops a conceptual model for analysing how e-Connectivity increases the operational effectiveness of a firm by providing the platform for dynamically linking the information flows of supply chain partners. The research focuses on short-term inter-firm supply chain relationships, and emphasizes how e-Connectivity can lead to improved customer service by improving the coordination between manufacturers, service providers, channel partners, and other partners that are involved in delivering products and services.

Based on a literature review and exploratory interviews,

initial findings suggest that supply chain theory does not sufficiently describe the interconnectedness and interdependencies between process and technology standards in a supply chain, and their effect on inter-firm coordination of supply chain resources.

Exploratory interviews were conducted between December 2004 and April 2005 with about 50 senior executives in person or by telephone. The interview panel consisted of senior management (C-Level, VP, Managing Directors, Directors) from a variety of industries. The Panel consisted of mainly European and Australian / New Zealand participants. The sample was chosen in this particular way as the researchers eventually want to compare Australian / New Zealand practices with practices in one other region of the world, and because they had access to relevant addresses and contact details. The panel composition is shown in Figure 1.

Figure 1: Exploratory interviews - Panel Setup

Expert Panel Industry	Country				Grand Total
	ANZ	EU	AMER	Asia	
Logistics Services	3		1	2	1
ICT	5	4			2
Durable Goods	3	2	1		9
Business Services	3	1	1		65
Financial Services	2	2			
FMCG	3			1	44
Automobile	3				3
Government	1	1			
Hospitality		2			2
Pharma & Chemical		2			2
Primary Industries	2				2
Utilities	1	1			2
Retail and Wholesale	1				2
Grand Total	33	15	3	3	54

In this context, there also appears to be insufficient empirical knowledge about the role that e-connectivity, i.e. technology and processes, play to enable dynamic supply chain relationships and ultimately lead to better outcomes. As such, opportunities for deploying the supply chain as a source for achieving quick response, operational effectiveness, and ultimately competitive advantage, may be lost.

We turn next to a literature review of supply chain relationships, and a discussion of dynamically networked supply chains. We introduce the role of information technology as an enabler for process change in supply chain management. We then turn to process and technology standards as the key factors driving e-Connectivity in supply chain management. This is followed by conclusions.

I. 1 Dynamically Networked Supply Chains

This research investigates market prospects that are highly dynamic and complex to execute and hence require a rapid coordination capability. Such advanced capabilities often do not exist in firms, or are inhibited because of established norms and formal approaches to managing the arrangements between the supply chain partners.

Handling complex and time-sensitive customer requirements frequently extends beyond the capabilities of a single firm [1, 2]. However, supply chain management not only needs to include the partners involved in core logistics and supply chain value adding activity, but also indirect partners such as regulators, intermediaries, financial institutions, and research and government agencies. These partners influence power, risk and knowledge structures which in turn impact on performance of supply chains. Swaminathan et al [2] define the supply chain as a network of autonomous or semi-autonomous business entities collectively responsible for procurement, manufacturing and distribution activities associated with one or more families of related products. Moeller and Halinen [3] interpret the supply chain as a network of entities where firms process information, so that they can better respond to linked partners and customers.

It is argued that expertise in coordinating activities across different firms will become an important supply chain capability in itself. This leads to the informally networked supply chain, a concept distinctly different from a more [...] simplistic, linear and unidirectional representation of flows of materials and associated information [...] [4]. This part of the research paper identifies key relationship attributes for coordinating e-business enabled supply chain capabilities in unpredictable market environments.

A paradigm shift is underway in supply chain management from a focus on explaining only dyadic relationships, i.e. transactions and relationships, towards the investigation of multidimensional relations and networked views of supply chain interaction. This is accelerated by the notion that existing categorisations of [supply chain] networks offer limited operational assistance [5, 6] for firms in understanding the full spectrum of how to leverage their capabilities in highly dynamic demand situations. It is proposed that networked supply chains represent differentiated coordination approaches depending on form and content of the inter-organisational relationships among the firms involved. It is further argued that coordination in networks supply chains in highly dynamic market situations is more responsive to dynamic relationships, time, information and other non-linear success factors in the exchange of inputs and outputs [7].

Networked supply chains are not consistently defined in the literature and vary depending on the research objective and the choice of dimensions. For our research, a classification of different supply chain network models is proposed in relation to varying network exchange relationships, as is illustrated in Figure 2.

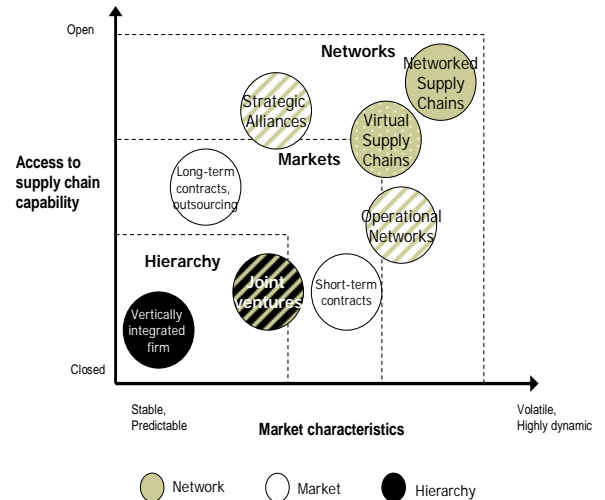


Figure 2: Landscape of supply chain networks

Formal coordination in either vertically integrated firms (internalising the coordination into the hierarchy of the own firm), through joint ventures and strategic alliances, or through long-term market contracts with 3rd party supply chain partners (using markets as the coordination mechanism) work in stable markets; while there is a risk that resources are not used efficiently in dynamic environments and stay idle most of the time. This leads to unnecessary costs and lowers operational efficiencies [8]. Examples of such rigid arrangement can be observed in the downstream mineral oil industry, which runs idle capacity for unpredictable or peak demands, or supply shortages. More flexible ways need to be introduced to cater for highly unpredictable demand.

The concept of outsourcing supply chain activities has often not produced the expected results for supply chain partners. Formalised relationships through contracts and service level agreements often increase complexities, and related efforts of coordination. Rigidity of such relationships inherent to contract specification, setup and monitoring, prevents firms to achieve competitive advantages. In particular, various ambitious new business models in the supply chain have not taken off as expected, i.e. the concept of a 4PL and e-marketplaces. Findings of a recent study on characteristics, strategies and trends for 3PL and 4PL in Australia [9] show that the benefits of inter-firm relationships have not yet materialised, although respondents confirmed the importance of such relationships for achieving better performance.

Networked supply chains display characteristics of the virtual enterprise [10],[11]. The relationship is temporary and project-like. Firms have specific capabilities, which they combine synergistically in the supply chain. The process is accompanied by an intensive use of information and communication technologies, and other network-specific coordination factors. In highly dynamic market situations, supply chain capability leverage depends on two important factors. First, generally accepted standards and methods in an industry or supply chain provide leverage for rapid

collaboration through network connectivity. Secondly, relational capability enables the rapid creation of a supply chain network for the opportunity at hand, and allows the partner to perform supply chain activities and serve the customer in highly dynamic markets.

Many firms coordinate their supply chain capabilities without formal agreements across a range of partners. As exploratory interviews reveal they anchor their activities around an understanding of dependency between business partners. Many firms have in fact indicated that they do not have any contractual relationships with their customers and suppliers for exactly the reason that their responses to market demand are highly adaptive, both in terms of response time and in terms of the breadth of solution delivered. These firms use their own and their partners' adaptable capabilities, including people, process and assets to respond to highly time-sensitive and complex customer requirements.

For example, it emerged from exploratory interviews that firms are reducing their assets and shift their attention to managing and controlling the access to information. This in particular seems to favour smaller players that can make an impact on supply chain effectiveness with relatively small shares of assets owned. Another example shows the electronics and automotive industries, where component suppliers are transforming into module suppliers, offering not only a narrow manufacturing expertise but a holistic service solution. This means that supply chain partners not only sell the product but provide services such as financing, maintenance, and replenishment [12].

Senior executives across a range of industries, i.e. chemicals, telecom equipment manufacturers, and fast moving consumer goods confirmed the informal coordination of supply chain capabilities to either enhance the efficiencies of operations, or to increase the effectiveness of serving the market with the 'best' combination of supply chain capabilities.

1.2 IT - Enabled Supply Chains

Networked supply chains connect the players and their capabilities through robust information linkages. There are several factors that distinguish traditional supply chain relationships to the ones enabled by networks and technology. These factors include a reliance of supply chain partners on information infrastructures (Amit&Zott, 2001), the critical role of visibility and information transparency, the high reach and richness of information that can be exchanged rapidly [13] and network effects [14, 15].

The evolution of supply chain technology and the way it enables relationships is illustrated in Figure 3, using Gattorna's [16] supply chain capability/performance continuum, which categorises three different levels of supply chain integration and synchronisation. This framework forms the basis for further analysis of supply chain relationships and the coordination of capabilities in the context of short-term opportunities.

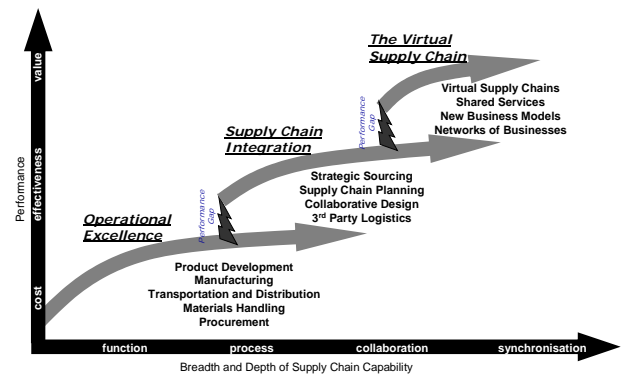


Figure 3: The supply chain capability/performance continuum (Adapted from Gattorna, 2003)

The first curve depicts the operational and functional, and often internal, focus of coordinating supply chain capabilities with the objective to improve cost and efficiencies. Efficiencies are important, but any collaboration at this level has limited effects on overall supply chain performance. Operational efficiency by itself is rarely sufficient to create competitive advantage in highly dynamic markets. By the same token, if firms don't have their own house in order, they should not even attempt to engage in advanced supply chain activity with external partners. Efficiencies form an important prerequisite for collaborating in highly dynamic markets. For example, if IT processes and management practices are setup and maintained to industry or supply chain standards, a readiness for collaboration that adds to overall flexibility can be achieved.

The second curve shows the integration of supply chain capabilities and the impact technology makes on supply chain design. As market and customer demands evolve, supply chain managers are prompted to find innovative ways to integrate processes and technology across supply chain partners. Technology enables integrated supply chain capabilities and the process of integration creates better information, increased visibility, knowledge and learning. For example, firms may have widely applied cross-organisational business process re-engineering and implementation of ERP systems in place to achieve the benefits of integration. Some players like Walmart in the U.S. and Tesco in Europe have introduced approaches like CPFR (Collaborative Planning and Forecasting). These early attempts to leverage the integration of processes and technology resulted in significant changes to the consumer goods industry, globally. Hence, such technology availability, standards, and ease of integration become an important enabler for supply chain collaboration.

Technology and process integration across firms also leads to an increase in outsourcing, or contract logistics. These are structures where external firms perform logistics activities like warehousing, scheduling and transportation, usually based on long-term contracts and service level agreements. The integration of information flows gives the principal firm control and visibility for managing the entire

process, even though the activities and the ownership of capabilities is decentralised. Gattorna et al [9] confirm that more than half of large Australian corporations use such services, and significant and growing ratios are quoted for Europe, U.S. and other regions [17-19]. Rigid information and process integration architectures, however, have failed to provide the capability to adequately respond to highly dynamic market requirements due to inherently rigid structures [20].

The third level suggests the emergence of virtual supply chains, i.e. the virtual networking of supply chain capabilities enabled by new technologies like the Internet. The activities are integrated and synchronised in real-time using open and closed platforms with associated standards. A range of vertical and horizontal e-marketplaces are examples of formalised virtual supply chain structures. These virtual supply chains promise new value creation and efficiency opportunities, but often fail to deliver the benefits due to complexities of contracting, coordination, and monitoring of agreements. Consequently, companies have now started to seek for new dynamically networked supply chain designs that allow for ad hoc coordination of capabilities across supply chain partners. Dell and Cisco are often quoted as examples that such designs are designs are feasible and illustrate the effectiveness of such models.

In interviews senior executives confirmed that the ability to dynamically network with business partners in the supply chain will be a key driver of profitability. Indeed, asked about the how revenue and profit attributable to the ability to dynamically work in networked supply chain relationships would change in the coming three years an overwhelming majority believed that it would increase.

I. 3 E-business Enabled Supply Chains

E-business can be loosely defined as a business process that uses the Internet or other electronic medium as a channel to complete business transactions. E-business has brought new opportunities and challenges to supply chain management [21]. The Internet, a global matrix of interconnected computer networks, is emblematic of the power of information flows, and intra- and inter-firm linkages in knowledge-intensive industrial development.

Firstly, the Internet has facilitated increased information sharing within and across company borders through use of enterprise resource planning (ERP). Other supply chain technologies have developed around the linkages of distributed systems. Traditionally information and geographically distributed applications were only available to internal users, or users of supply chain partners subscribed to a closed and relatively costly intra-net or value-added network (VAN).

As decentralised supply chain technology evolved information architectures were held together by systems such as electronic data interchange (EDI), electronic funds transfer (EFT), and more recently by internet based systems using extensible mark up language (XML) [2]. There has been a proliferation of technology platforms, using lighter-weight protocols for creating electronic bonds, such as e-

marketplaces (e.g.. E-Steel) or hubs (e.g.. Covisint), as well as tools for inter-enterprise integration (e.g., Webmethods).

Secondly, the ability to obtain real time information and access to large computer systems is enabling firms to optimise business processes across company boundaries, and make real-time decisions on a supply-chain level. The application architectures included internet based versions of ERP systems, best-of-breed applications connected through middleware, and advanced planning and optimization solutions (APS), all transcending traditional company boundaries.

Further, there are a number of industry and IT vendor-driven efforts to standardize business processes and data exchanges between enterprises, which are expected to yield network externality benefits in easing partnering across enterprises, as well as dealing with change in existing partnerships. Interoperability frameworks have been developed for vertical markets (such as the Information and Content Exchange and RosettaNet specifications) and horizontal markets (such as Microsoft BizTalk), but have not been widely deployed [22]. In this context the Internet has created opportunities to integrate information and decision making across different business organisations and functional units, thereby creating the possibility to build and scope the extended enterprise – a virtually integrated set of applications and processes permeating traditional company boundaries [23].

Lastly, technology integration remains a challenge. A number of organisations are trying to overcome integration challenges by focusing on the development of process and technology standards [24].

Extant studies suggest that, the greater the degree of coupling or integration between the information systems of trading parties, the greater the degree of coordination and collaboration that can be achieved [25]. This suggests that firms wishing to improve the performance of their supply chain operations should invest in establishing closely coupled links between themselves and their trading partners.

In the electronic environment, customer expectations have increased as to quick and timely delivery. At the same time, the Internet has opened up opportunities for firms to share information, and efficiently coordinate their activities with other entities in the supply chain. This has created alternate avenues in traditional supply chains for doing business. For example, in supplier selection and procurement, firms have to decide whether they should join private or public exchanges, or develop highly-integrated supply partnerships. They need to determine if they should use auction and bidding for contracts and, if so, which type would be most beneficial. In distribution, decisions need to be made whether the firm will offer products through the Internet channel and, if so, how this method would differ from the traditional channel. This raises the question of how the synergies would be realized in terms of inventory, transportation, and distribution. Similarly, the availability of real-time information has raised important questions such as the degree to which the information sharing protocol should

be standard or proprietary; the amount and type of information that should be shared with other supply chain partners; and the types of collaborative processes that may be beneficial. The degree of change in issues related to the supply chain spans a huge spectrum from concepts and issues that have been marginally affected, to a whole set of new issues that have emerged as a result of e-business [26].

These outcomes support the proposition that if relationships in the supply chain become more dynamic and, more importantly, contribute significantly to companies' results, then attention must be given to the prerequisites for integration and connectivity. The following paragraph discusses this notion in the context of eBusiness.

II. E-enabled Supply Chain Coordination Through Standards

II.1 Coordination Standards

Technical and process standards are a major enabler for ad hoc and efficient supply chain collaboration. Networked supply chains connect the players and their capabilities through robust information linkages. There are several factors that distinguish traditional supply chain relationships to the ones enabled by networks and technology. These factors include a reliance of supply chain partners on information infrastructures [27], the critical role of visibility and information transparency based on reliable data, and the high reach and richness of information that can be exchanged rapidly [13].

Unlike traditional supply chains where activities and transactions are tied to specific physical assets and locations, electronically enabled infrastructures are designed to replace physical exchanges by information, thus creating virtual business models [29]. Electronic information exchange allows firms to arrange commercial transactions that bypass significant portions of traditional business transaction costs typically incurred at various stages of value chain activities, such as delivering tangible products between buyers and suppliers, managing inbound logistics, and controlling distribution channels.

The possibilities of electronic coordination also help firms speed up traditional business transactions. Thus, in the virtual supply chain, information and information processing capabilities that increase efficiency and/or convenience in networked supply chain relationships requiring coordination, become a critical source of competitive advantage. These capabilities often become tools to reduce transaction costs [30-32].

The Internet can be used to establish direct contact over a widely dispersed set of customers. Dell Computer's well-documented direct marketing experience indicates how the clever use of an interactive electronic channel allows an industrial marketer to bypass traditional distributors. In this sense, the Internet and the emerging e-commerce solutions may rapidly change the power position between current distributors and marketers, and facilitate the appearance of

virtual firms that have externalized value activities such as product development, production, and logistics, customer creation, and customer portfolio management through databases. In addition, the standard aspects of these "virtual competencies" may very well be handled through supplier partnerships with competitive service providers.

The Internet allows for standardized transacting procedures shared by many partners, and an open architecture of connection known as the World Wide Web [33]. Internet procurement has emerged with the help of "orchestrated" markets called business-to-business (B2B) exchanges. B2B exchanges create an electronic marketplace with low-cost entry and standardized transactional procedures – e.g., the display of buyer's specifications, bidding procedures, market clearing, safeguarding, and so on. Interdependencies are pooled because the bidding process is impersonal and carried out by autonomous suppliers.

II.2 Information Exchange Standards

Standardization of process and content interfaces refers to explicit or implicit agreements on common specifications for information exchange formats, data repositories, and processing tasks at the interfaces between interacting supply chain partners.

Standardization of process and content interfaces would require business partners to agree on the syntax, semantics, and pragmatic aspects of documents that are to be exchanged for the specific process being coordinated. The lack of standardization means that exchanges are idiosyncratic to each relationship. For example, a distributor in the IT industry reports spending \$17 per SKU (stock keeping unit) by having to manually update information on the 100,000 SKUs it manages yearly, due to different reporting formats used by manufacturers. On the other hand, the use of standards, such as UCCnet standards for product data in the grocery industry, is expected to cut costs by as much as \$40 billion by providing a common business language [30].

Standards play an important role in structuring relationships between companies—they help reduce the extent to which market exchanges are personalized and the scope for unethical and opportunistic behaviour. Coordination theory suggests that standardization allows for management of interdependencies, making the infrastructure more flexible and capable of supporting change. The effect of standardization on partnering flexibility is expected to be positive, given that standardization creates network effects, reduces the variety of asset and informational specifications, provides for a wider set of users, increases frequency of transactions, and reduces market uncertainty. The effect of standardization of interfaces on offering flexibility is also expected to be positive, as it helps in the establishment of a technical grammar that reduces the amount of information that needs to be exchanged between enterprises, and enables social conventions to be established to facilitate coordination in the face of change [30].

Open technology standards, particularly the ones related

to the Internet, greatly reduce marginal transaction costs of information for additional users or products, resulting in network effects. The ROSETTANET consortium, for example, is a non-profit group of more than 400 companies in the information technology and electronics domain, which aims at standardizing the trading networks between these companies by providing standards for business documents (e.g. purchase orders), as well as so-called partner interface processes (PIPs), which define process interaction between trading partners (e.g. acknowledgement of receipt etc.) [34].

Standardised application of software and hardware has improved the visibility of activities performed in supply chains across organisational boundaries. In particular, the advent and proliferation of enterprise resource planning (ERP) software supported rapid process integration within, and later across, companies. Wal-Mart's RetailLink is a buyer-based Internet exchange which connects Wal-Mart with more than 2,000 suppliers. Sales, inventory, production schedules, and demand forecasts are shared through the exchange, which is a key enabler for helping Wal-Mart achieve its supply chain excellence. Another example is Taiwan Semiconductor Manufacturing Corporation (TSMC), which is one of the world's largest contract manufacturers for integrated circuits. Through its private exchange with its customers, TSMC shares forecasts, order management information, WIP updates, and engineering specifications, allowing it to reduce customer lead times while lowering its inventory carrying costs.

Information exchange is a characteristic of networked supply chains. Through connectivity critical participation within a supply chain can be enabled. Connectivity can be defined by how many supply chain partners a business can connect with, and how comprehensively information can be exchanged. Standards are a key prerequisite for achieving connectivity.

Messaging standards integrate corporate information across the supply chain through mechanisms such as EAI middleware, based on the existing infrastructure. While a number of interoperability issues remain, a consolidation of the number of standards is very likely. Approaches such as SOAP, ebXML, ROSETTANET and WSDL have found widespread acceptance, and form a complementing framework of XML standards for inter-organizational messaging applications [34]. The operational aspects of business-to-business interactions are quite well defined, and the generation of analytical data from the operational processes provides a standardized foundation.

EDI is one such messaging standard that involves computer-to-computer exchange of information between buyers and suppliers [29]. Early (or closed) EDI systems, which gained momentum especially in the 1990s, are associated with specifically negotiated codes and a proprietary, or closed, electronic architecture to transfer information. According to Holland et al. [29], early EDI systems are "used to encourage close trading relationships with a smaller number of suppliers." As such, early EDI systems involved investments by both parties in private

computer connections and training, implying a closed architecture of connection and agreements specifying information transfer codes [35]. Many authors document two main advantages of early EDI systems: a potential reduction of transaction costs, including procurement and monitoring expenses [35], and the optimization of production through information sharing [29], shortened lead times [36], inventory reduction, and increased product quality [32]. These sources of value are strongly associated with sequential interdependencies. Additionally, private communication systems are commonly implemented by a systems initiator (e.g., a buyer), "who deploys a proprietary [system] to expand the scope of hierarchical control" to a particular firm (e.g., a supplier), "which exercises the choice between accepting or rejecting" the new system [24]. This has clearly a flavour of plan-based coordination.

At a major router manufacturer, it was observed that specific inter-enterprise IT characteristics may hinder the ability to quickly link up with new partners:

"We are in the continuous process of evaluating who can best meet our needs. If a new third-party logistics provider becomes available, how can our company get up to speed to using them? In the past, the problem was predominantly defined by physical changes, such as location, system changes, and interface changes, which can take as much as six months. The current strategy for coordination with our partners, however, relies on hardwired APIs (application interfaces). When anything changes, they falter. We need to move toward more abstract specifications that will enable us to handle changes much better."

II. 3 Process Standards

Flexibility to build ad hoc relationships represents the ease of changing supply chain partners in response to changes in the business environment. Flexibility in terms of the ability to change partners quickly corresponds to an ability to work out how the new partner's capabilities can be quickly accessed and deployed. This can be done by a redesign of partner-linked processes and systems. In EDI implementations, it has been found that adoption requires substantial investment and integration effort, resulting in high switching costs and transaction specificity, which in turn undermines flexibility. On the other hand, open EDI systems increase market coordination by reducing asset specificity and by making additional partners available. Whereas information systems improve the efficiency of coordination between buyers and suppliers, managerial innovations—such as modular product designs, "quick-connect" interfaces, and use of IT to support concurrent processes and real-time acquisition of market information—significantly improve a firm's coordination flexibility.

In order to enable transparency and visibility in the supply chain, standards have emerged through advances in and proliferation of information and communication technology. Connectivity enables transparency, i.e. the ability to access relevant supply chain information. Transparency can be achieved through standardization of the

data, information and process models.

Connectivity reduces barriers and associated transaction costs for establishing supply chain linkages. In networked supply chains, the internet and open technology standards greatly reduce transaction costs of information. For instance, travel agencies which have the ability to quickly tap into a broader range of relevant information through suites of freely available and contracted online services (i.e. Gallileo and Amandeus, country and tourist information web sites and accommodation information), can serve more customers, provide greater selection, and more complete services.

Process standards create better information, increased visibility, knowledge and learning. Process standards across firms enable network capabilities. Firms can access the capabilities of another firm to perform logistics and supply chain activities like warehousing, scheduling and transportation. While this has usually been based on long-term contracts and service level agreements (outsourcing), shorter-term, interimistic arrangements are feasible.

The integration of standardised processes and information flows gives the principal firm control and visibility for managing an end-to-end process, even though the activities and the ownership of capabilities are decentralised. Research in Australia, Europe and the US confirm this trend [17-19].

The Supply Chain Operations Reference (SCOR) Model provided by the Supply Chain Council specifies inter-organizational business processes and their information flows [21, 37]. The SCOR Model contains measures for operational control and best practices of supply chain design, and is a reference model for structure, processes, and information flow within an inter-organizational supply chain [38]. As a result, the SCOR model needs to be extended with a framework for the adjustment of internal and external business processes, in order to align an existing process infrastructure with the inter-organizational processes that are the result of a SCOR approach [39].

Supply chain wide routines enable the development of information systems as the backbone of integrated supply chains [38]. Information technology is widely perceived as the enabler for supply chain integration [40]. Firms participating as partners in a supply chain have to provide their capabilities in a way that maximizes the supply chain efficiency and effectiveness by concentrating on their core competencies.

We posit that improvement in an enterprise's information processing capabilities with reference to a supply chain relationship will allow its supply chain linkages to better support reconfiguration of offerings and partnerships.

The above discussions are summarized in Figure 4, which depicts the main factors that influence e-connectivity and the outcome of e-connectivity in producing increased flexibility and supply chain coordination.

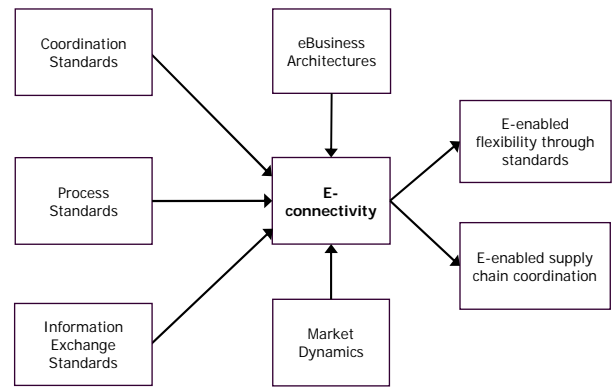


Figure 4: e-Connectivity in dynamically networked supply chains

III. Areas for further research

The paper has outlined the key concept for eConnectivity in supply chains. While this concept was validated through a literature review and expert interviews, an area for further research focuses on empirically validating the relationships between technology, process and management standards, and how they lead to improvements in connectivity and performance. This will subsequently provide additional insight for improved supply chain design.

IV. Conclusion

This paper has identified a number of drivers and enablers in an eBusiness context that supply chain partners can use to create quick and flexible linkages in their supply chains for leveraging their respective capabilities. The e-connectivity construct was introduced and examined, as it was established that information integration and resulting supply chain visibility is a key factor for quick decision-making in the supply chain.

Through a literature review and exploratory research with industry experts, the study concludes that technology is only but one key driver. Existing and further emerging technology standards enable companies to connect their operations systems easier and quicker. Standards supporting the establishment of information platforms, technology infrastructures, and process methodologies have become drivers that enable connectivity for eBusiness.

In order to achieve superior performance, our preliminary results suggest that processes and the mechanisms for coordinating capabilities need to be aligned within the capability technologies have to offer.

The findings further suggest that e-enabled supply chain infrastructures provide companies with faster and richer information, and hence allow supply chain partners to make appropriate decisions in highly dynamic market situations, allowing the entire supply chain to become both more adaptive and more proactive in capturing value opportunities.

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Design Distribution and Evaluation Model for Collaborative Design Chain

Yuan-Jye Tseng^{*1}, Huei-Ling Tzeng¹, Yu-Hua Lin²

¹Department of Industrial Engineering and Management
Yuan Ze University

135 Yuan-Tung Road, Chung-Li, Taoyuan 320, Taiwan

²Department of Marketing and Logistics Management

Hsiuping Institute of Technology, Dali City, Taichung 412, Taiwan

^{*}Corresponding author: ieyjt@saturn.yzu.edu.tw

Abstract: A collaborative design chain incorporates the different design activities performed by various design teams that may be located at different geographical locations. In a collaborative design chain, the different parts of a product can be designed by different design teams in a collaborative way. There exist different ways for distributing the different parts to the multiple design teams. If different ways are used for distributing the different part, the time for completing the design and the final functions of the product may vary. In this research, a design evaluation model for evaluating the collaborative design chain is presented. The presented new model is aimed at finding the best way for distributing the different parts to the suitable design teams such that the designed functional value of the product can be maximized. Also, the design cost composed of design operation cost and design communication cost in collaborative design is minimized. An optimized design distribution and evaluation model is presented by maximizing the total design value which is defined as the designed functional value minus the design operation cost and the design communication cost. Implementation and test results are presented.

Keywords: Collaborative commerce; SCM; Collaborative design; Design chain; Multi-plant

I. Introduction

With emerging e-business models in a global supply chain, the demand of new products from customers is growing and the time to market for a new product is shortening. As a result, the demand of new products with more new functions is increasing. In addition, the design cycle time for designing a new product needs to be reduced.

To satisfy the above demands, collaborative commerce models are introduced. In a collaborative design model, the different parts of a product can be distributed and designed by different design teams at multiple sites at various geographical locations. The main idea is that the different portion of a product can be assigned to a suitable design team which is specialized in designing the portion. In this way, the functions of the final product can be enhanced since each portion is designed by a specialized design team. Moreover, the design operations can be shared by the

multiple design teams in a concurrent way to reduce the design time. The purpose of collaborative design is to distribute the design tasks to the suitable design teams to achieve the objectives of reducing design time and increasing product functional value.

A collaborative design chain integrates different design activities performed by various design teams in order to complete the final product. The design activities mainly include design operations and design communications required for performing the design tasks. In a collaborative design chain, there may be certain added value that can be gained as a result of a collaborated design activity. Also, there may be additional cost generated because of a collaborated design activity. The value and cost created by the collaborated design activities and the multiple design teams may be more complicated than a single design team. Therefore, the gained value and the additional cost occurred in a collaborative design chain need to be analyzed and evaluated.

In this research, the total design value of a designed product can be evaluated by two main categories, the functional value that the designed product creates and the design cost that takes to produce the designed product.

The functional value of a designed product is created by the functions that the product can perform. If there is a good or a special function required by the customers, then the product can sell with a higher price. Therefore, it is a goal that the functional value can be increased.

However, a good functional value may be the result of a higher design effort. Therefore, more design operation time and more design communication may be needed in this type of a collaborative design model. Since a collaborative design chain is composed of different design teams, if a product is designed by different combinations, the product functional performance may be different. Also, because the different design teams may design the product differently, different design communication time may be required.

Therefore, for a collaborative design chain, it requires a systematic way to evaluate the total design value of the designed product. In this research, the total design value is defined by the designed functional value, the design operation cost and the design communication cost. This is represented as total design value = designed functional value – design operation cost – design communication cost. It is the purpose of the research to distribute the design tasks to the suitable design teams such that the total design value can be maximized. This can be represented as

$$\text{Max } \{D = (F - T - C)\},$$

where D = total design value,

F = designed functional value,

T = design operation cost,

C = design communication cost,

In the related research by Kvan [5], the meaning of collaborative design and computer-supported collaborated design is discussed. A recent review by Fuh and Nee [3] summaries the related works using the distributed CAD approaches using the latest IT tools to support the collaborative design activities. A comprehensive review of related work in research and development of software tools and methodologies to support distributed and collaborative design can be found in Li et al. [6]. Recent research focuses on three main topics: visualization of 3D CAD models, co-modeling of 3D CAD models, and developing distributed design environment. The related research work can be found in a web-based conceptual design prototype system presented by Qin et al. [8], a collaborative product conceptualization tool using web technology by Roy and Kodkani [10], a feature-based collaborative design by Wang et al. [13], a distributed object model for collaborative CAD environments by Barbosa et al. [1], and a process-oriented intelligent collaborative product design system, by Li et al. [7]. The related research by Tseng et al. [8] focuses on design module modeling and design task assignment in a collaborative design model.

Based on the review, previous research work focuses on developing a framework for communication of design and exchanging of data using the internet and web-based technology. Although much has been accomplished on the internet framework, it shows that little work has been done on the planning and evaluating aspect of a collaborative design process. It requires a planning and evaluating model for decision-making of a suitable way to distribute the different parts such that the cost and functional performance of the collaborative design chain can be optimized. This research presents an evaluation model for a collaborative design chain for distributing design tasks to available design teams with a maximized total design value.

II. Design Task Distribution and Design Evaluation Model

The concept of maximizing total design value can be formulate as follows. To formulate the problem under investigation, the following notations are used.

Notations:

n : design task,

k_n : part in a product,

d : design team,

p : designer,

P_{G_d} : designer in design team d ,

$T_{pn(k_n)}$: the design communication cost,

$C_{pn(k_n)}$: the design operation cost,

$F_{pn(k_n)}$: the functional value (same unit with cost) obtained,

$x_{pn(k_n)}$: decision variable,

a_{nd} : decision variable,

Objective function:

$$\begin{aligned} \max \sum_n \sum_d \sum_p \sum_{k_n} a_{nd} \times x_{pn(k_n)} \times F_{pn(k_n)} - \\ \sum_n \sum_d \sum_p \sum_{k_n} a_{nd} \times x_{pn(k_n)} \times T_{pn(k_n)} - \\ \sum_n \sum_d \sum_p \sum_{k_n} a_{nd} \times x_{pn(k_n)} \times C_{pn(k_n)} \end{aligned} \quad (1)$$

Constraints:

$$\begin{aligned} \sum_p \sum_n \sum_{k_n} x_{pn(k_n)} \times C_{pn(k_n)} &\leq 1 \\ F_{pn(k_n)} &\geq 0 \\ T_{pn(k_n)} &\geq 0 \\ C_{pn(k_n)} &\geq 0 \\ \sum_d a_{nd} \times (\sum_p x_{pn(k_n)} \mid p \in P_{G_d}) &= 1 \\ \sum_d a_{nd} &= 1 \\ \sum_n \sum_{k_n} x_{pn(k_n)} &= 1 \\ a_{nd}, x_{pn(k_n)} &\in 0, 1 \end{aligned}$$

The model is formulated with an objective of maximizing total design value which is defined as the designed functional value minus the design operation cost and minus the design communication cost.

The output information of the model is as follows:

1. The designer in a design team assigned to design a part,
2. The design completion time for designing all the parts in a module,
3. The design completion time for designing the product
4. The final product functional value.

III. Implementation And Test Results

Test software system has been developed on a personal computer to implement and test the presented model.

Several example products are tested. In this section, a mobile phone is used as an example product to show the model and the tested results in this study.

With the input information of the example product, the design distribution and evaluation model is performed. The model is solved using a linear programming solution method. The final results of design evaluation and distribution are shown in Table 1.

According to the model developed in the study, a maximized total design value can be obtained. From the example, it shows that the developed model presents a feasible evaluation method with an optimized result. It is observed that in practical cases, the presented model can be useful for most common commercial products to achieve the objectives.

IV. Conclusion

In a collaborative commerce model, a design may be distributed and performed by different design teams in a collaborative design chain. In this paper, a design evaluation model for evaluating the collaborative design chain is presented. In a collaborative design chain, different ways for distributing the parts of a product to multiple design teams may result in different design completion time and different product functional performance. In this research, the value and cost issues in a collaborative design chain are identified and defined. Based on the value and cost issues, an evaluation model is developed. The presented new model is aimed at finding the best way for distributing the different parts to the suitable design teams such that the designed functional value of the product can be maximized. An optimized design distribution can be obtained by maximizing the total design value which is defined as the designed functional value minus the design operation cost and minus the design communication cost. In future research, a more complete model can be developed with more detailed value and cost objectives for evaluating collaborative design chains.

Table 1. Test results of the example product.

Design task n	Part (k_n)	Part name	Design r (p)	Design team (d)
1	1	Upper case	P ₁	D ₁
	2	Back case	P ₄	
	3	Keyboard	P ₅	
2	4	Keyboard conductor	P ₅	D ₁
	5	Keyboard controller	P ₂	
3	6	Earphone	P ₉	D ₂

4	7	Speaker	P ₉	D ₄
	8	Microphone	P ₁₉	
	9	Power switch	P ₁₈	
5	10	Vibrator	P ₂₀	D ₂
	11	Battery	P ₁₀	
	16	SIM card frame	P ₁₁	
7	12	LCD	P ₂₁	D ₅
	13	FPC	P ₂₄	
	14	Backend IC	P ₂₅	
8	15	PCB	P ₁₄	D ₃

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A Refinery of an Internet-Based Search Tool – Exploring Perceptions from Information Systems Practitioners

Michael Chau¹, Ivy Chan²

¹School of Business, Faculty of Business and Economics
The University of Hong Kong, Pokfulam, Hong Kong

E-mail: mchau@business.hku.hk

²Department of Decision Science and Managerial Economics
The Chinese University of Hong Kong, Shatin, New Territories, Hong Kong

E-mail: ivychan@baf.mssmail.cuhk.edu.hk

Abstract: In today's dynamic business environment, the capability to understand the needs and responses of stakeholders is critical as such management can devise effective plans and course of actions for long-term strategies. The advancement of the internet and its related search tools such as Google, has helped management to collect various information in order to keep abreast of time of business environment and their business communities. Yet, the management has encountered problem and uncertainty on the information quality such as content, currency, accuracy and presentation. Therefore, a new backlink search tool, namely Redips was developed. This tool has been tested by students subjects with satisfaction. However, in order to gain acceptance from the management (i.e., the end-users), the perceptions and expectations on the tool should not be overlooked. This study presents a wide range of perceptions from a group of Information Systems practitioners on the potential use of Redips.

I. Introduction

The World Wide Web presents significant opportunities for business intelligence analysis as it can provide information about a company's external environment and its stakeholders. Traditional business intelligence analysis on the Web has focused on the simple keyword searching. Recently, it has also been suggested that the incoming links, or backlinks, of a company's Web site (i.e., other Web pages which have a hyperlink pointing to the company of interest) can provide important insights about the company's "online community". Analysis of these communities can provide useful signals for a company or information about its stakeholder groups, but the manual analysis process can be very time-consuming for business analysts and consultants. In this paper, we present a tool called Redips that integrates automatically backlink meta-searching and text mining techniques to facilitate users in performing such business intelligence on the Web. We also report a focus group study involving IS practitioners to study the potential uses and user perception of the proposed tool. The rest of the paper is structured as follows. Section 2 reviews the importance of Web communities in business intelligence analysis. Section

3 presents the proposed tool and its architecture. In Section 4 we discuss our methodology and the focus group study. The preliminary results are presented in Section 5. Finally we conclude our study and suggest future research directions in Section 6.

II. Web Communities

The Internet has many well-known explicitly defined communities – groups of individuals who share a common interest, together with the Web pages most popular amongst them [10]. The Web communities consist of the following stakeholders of the firm: customers, suppliers, competitors, regulators, employees, educational institutions, court and legal institutions, financial institutions, stockholders, public-interest groups, labor unions, political parties, federal, state, local governments, etc. [11]. The stakeholders listed here can be classified into two categories: explicit and implicit Web communities.

Explicit communities are the communities that can be easily identified on the Internet. Kumar et al. [8] discussed the Porsche newsgroup as an example of explicit community of Web users interested in Porsche Boxster cars. Such communities are often found in resource collections in Web directories such as the Yahoo directory. Explicit communities are easy to be identified and analysts can simply use manual method to find a firm's explicit communities by browsing the firm's newsgroup or the category in which the firm belongs to in directories like Yahoo on the Internet.

Implicit communities are relatively more difficult to be found using a manual browsing method. According to Kumar et al. [8] implicit communities refer to the distributed, ad-hoc and random content-creation related to some common interests on the Internet. These pages often have links to each other, but the common interests of implicit communities are sometimes too narrow and detailed for the resource pages or the directories to develop explicit listings for them. As a result, it is more difficult to find the implicit communities of a firm. In identifying the explicit and implicit communities of a firm, it is reasonable to assume that the content pages created by these communities would provide hypertext links back to the firm's homepage for reference [10]. Therefore, in order to find a firm's online communities, it is necessary to find the Web pages that have

hyperlinks pointing to the firm's URL, i.e. the inbound links of the firm's Web site.

The identification of Web communities, irrespective of explicit communities or implicit communities, is important to the strategic planning process. The strategic planning process consists of five steps [3], namely, mission and objectives, environment scanning, strategy formulation, strategy implementation, evaluation and control. The extraction of Web communities is classified to the environmental scanning step in the strategic planning process. The information would be used for the analysis of the firm's industry for evaluating entry barriers, suppliers, customers, substitute products and industry rivalry.

III. Redips

Our proposed system is called Redips. The term "Redips" is the reverse spelling of the term "Spider". Traditional Web spiders (crawlers) search the Web by following outgoing links. However, in our proposed tool, we search based on the "incoming links" of a page. These incoming links can help identify the Web communities of the firm of interest.

Redips has been implemented based on the MetaSpider system developed in our previous research [6]. The main modules include the user interface, spider, Arizona noun phraser, and self-organization maps. User interface is the first point of contact between the user and the system. Spider fetched the URLs returned from those search engines. Arizona noun phraser is a natural language processing tool to do the key phrase extraction from Internet text. Self-organization maps visualize the concepts in a two-dimensional map. The technical details of the modules are discussed in another paper [5]. Here, we will present a search session with the tool from the user's perspective.

When using Redips, a user should first enter the Web site to be analyzed and the backlink search engines to be included. A sample user session with Redips is shown in Figure 1. In this example, the Web site entered is <http://www.ibm.com/>, the homepage of the IBM Web site. Optionally, the user can enter the keyword(s) to be included in the returned Web pages. The user may also specify some other search options. In this step, the user can define the intelligent analysis objectives, e.g. the firm, information source, topic, in the analysis process. After starting the search, multiple threads will be generated to start getting Web pages from the Internet. The URLs returned by the search engines will then be displayed. The user can browse these pages for exploratory, preliminary research in this step.

IV. Research Methodology

As discussed above, there are a number of new attributes embedded in Redips, which facilitate information search and add values to the management in strategic planning. Yet, the attributes of Redips perceived and developed by the system developers may be different from those of the business managers. In order to provide an effective and practical tool,

the views and comments from IS practitioners who are rich in IS knowledge and currently engage in business planning, leadership and strategic analysis are examined. The current study adopts focus group study (as an effective research method) to dig in and explore various perceptions from the IS practitioners, as such to enrich our understanding of the practicability and usefulness of Redips.

Focus group discussion is a qualitative method to trigger and solicit extensive pool of opinions that capture the respective dimensions of the domains or topics to be addressed or investigated, particularly newly emerged and illuminative concepts [7,9]. Generally speaking, focus group is a method conducive to communication through a two-hour back-and-forth discussion and interaction among a small group of individuals (usually six to ten persons). A moderator is enlisted to facilitate the discussion (e.g., to ensure topics and issues are conversed, commented upon and incorporated). In our current study, one focus group discussion was conducted. The group was composed of six practitioners (in their mid-thirties) with an average of 12 years of industry experience. They discussed on the search approaches, pros and cons of commonly used internet-based search tools. Thereafter, they engaged in a 30-minute hands-on of the Redips and explicated their opinions from various views. Large amount of broad-based ideas in participants' own words, while relatively inaccessible using other research methodologies can be obtained [4]. The coding and analysis of the data, thereby can be used to develop thematic scheme to reveal the scope, details and multiple facets of the constructs or ideas in proposed work [1, 12].

The focus group study serves as the beginning stage of research. We intend to use a mix of techniques to make sense of the qualitative data collected from the practitioners. A research plan with three stages is detailed as follows:

Stage One. In order to understand how users perceive and evaluate new systems, a reference to existing IS literature was undertaken. The pertinent literature is used as a foundation to outline the topic agenda used in the focus group sessions, while refrained from the actual discussion.

Stage Two. A series of focus group sessions is planned to be conducted. The first focus group discussion was held in August 2005 which provided a lot of useful feedbacks of Redips. More focus group sessions are planned, involving business executives from non-IS functional areas (such as sales and marketing sections in their organizations) of which the executives are expected to use the Internet-based tool frequently in their daily tasks.

Stage Three. Data collected (in handwritten notes and audio tapes) from different focus group sessions will be firstly compiled with the assistance of the computer. The results will thereby be compared and assimilated. A validated and accuracy check was conducted to compare the summary and the original transcripts. The adoption of thematic categorization [1,2,12] involves the articulation and construction of potential themes and facets of constructs that correspond with the research questions. The potential themes

were considered as a reflection of the attributes or dimensions captured under each construct. To ensure no interpretive perspectives would be lost, the transcripts (recorded in word documents) were sorted and allocated to the emerged themes using a cut and paste technique. Throughout iterative rounds of discussion and reconciliation, the discrepancies of interpretation were resolved to devise a theme summary. The theme summary includes coding systems, themes titles, descriptions, relevant examples and indicative keywords. To ascertain the effectiveness and accuracy of the system evaluation theme summary, further comments were sought from other experts (who are not involved in any stage of the current study).

V. Preliminary Results

The first focus group session was held, with large amount of ideas and opinions were sought. In essence, the practitioners are satisfied with the existing tools, in regard to its low cost (usually free of charge) and ease of use. However, the information quality in terms of amount, currency and presentation has presented limitations to their business decisions. The participants reveal that Redips can add value to their managerial tasks, as it streamlines the information search, and enables effective assessment of the Web

communities and stakeholders. A common assertion was sought that they will use Redips in addition to the existing search practice.

Some key preliminary findings are summarized as follows:

The practitioners had named Yahoo and Google as two commonly used Internet-based tools in their daily work. There are some extraordinary occasions that they may seek information from other search tools (such as www.altavista.com) given the two common tools did not provide adequate information for their purposes.

To evaluate an effective and desirable system, nine attributes are assimilated from the opinions sought in the focus group discussion (Table 1). Redips' performance shows a good match and desirable attributes with those expected by the IS practitioners. The attributes are ranked according with the number of respondents who solicit the respective aspect. Therefore, a higher the number in the bracket indicates a more common issue being conceived in the discussion session. It should be noted that one of the advantages of focus group discussion is to provide analytical generalization of what participants think and perceive, therefore, it is not meant the higher the number of a respective attribute as more important one.

Table 1. Desirable Attributes of an Internet-based Search Tool and Redips

Desirable Attributes	Details and Descriptions	Redips
Time (6)	Short and prompt search time	Quick response and fetching time
Cost (6)	Free of charge	Free of charge
Search results (6)	Links should be ranked with relevance and currency of the information	Web pages are fetched in real-time to avoid outdated indexes
Learning efforts (5)	Minimum, ease of use without attending formal training	Easy to use, logical and order search process
Technical resources (4)	No additional software be installed	Requires installation
Interface (4)	User-friendly and attractive	Practical and clean, user-friendly buttons
Language (3)	Multiple language	Limited to English
Personalization (2)	Customization of specific search requirements, prior search records	Three search engines (including Google, MSN and AltaVista) can be previewed at the same time; phrase selection to remove unrelated pages
Assistance (1)	Help, search tips and data recovery	Help menu available

Contrast to our result-oriented system design, the IS practitioners who are experienced in system development and engage in business planning share similar perception and valuation criteria that are close to those of end-users'. Most of the participants showed empathy on the business managers' pressure in time management. A system analysis manager stated that the tool should be time saving, with results displayed with highly relevant, clear, easily be

comprehended and useful content. Two other participants supported his views as they claimed the business development managers in their organizations are "extremely" hard working as they usually work for more than 54 hours per week, thus they cannot afford information search process that "wastes" their time. Therefore, they stated that the search process should be time-effective, with minimum search and loading time. They commented further

that long loading time will increase the tendency to abort the search process, thus, unfavorably affect managers' time management.

While discussing the approaches in search of information or business intelligence, the practitioners stated that their search approaches vary from task to task. One IS department assistant manager stated that if he looks for new business opportunities that he has little experience about it or the request is made on ad hoc basis, he may seek information exhaustively until the relevance of the search results diminishes. He explained "I will seek help from experienced staff within organization. Yet, sometimes good business ideas are not generated from internal people as they are indulged to the existing success. Those competitors, discussion groups provide lots of comments to our existing services, despite their words are unpleasant. Listening to our customers can let us know our inefficiency and what we need to do more." Otherwise, if he handles regular review of market positioning, he will approach a satisfactory manner. He stated "my personal experience is rich and validated in my past success. Therefore, I know when and where to get the relevant information for routine tasks, and know when to stop."

In regard to the propagation of Redips, a senior system engineer pointed out that a good design does not make the system successful and well accepted by users. He stated, "Our colleagues have a strong social network which shared lots of latest information and users' feedback on various tools." Therefore, he suggested "the success of Redips is not a mere concern of physical design and functionality; rather it is determined by the consumers who foster a good perception at the beginning. If the comment is positive, the word-of-mouth will leverage users' interest and attention to Redips." A senior software development manager put forth the opinion and stated that management should not underestimate the power of management commitment and network effect. She gave an example that a new software system was well accepted in her organization, despite the brand equity of that software system is not high. It is because the management has shown a strong support, clear vision and commitment to deploy across all departments. Middle management also plays an important role to monitor the roll out of the system. Furthermore, she recalled "most of our colleagues believe that they should get on the same board (i.e. adopt the new system) in order to become one of the majority."

VI. Conclusion

The internet-based backlink search tool, Redips provides an alternative way to assess various web communities and infer business intelligence to managers. In order to enhance its practicability and usefulness to business managers, the current study adopted focus group method to drill in various

perceptions and views from a group of IS practitioners. In essence, they find Redips and assert its value in business planning and decision making. Our present study will be continued and extended as proposed the three-stage research tasks. The nine attributes and specific findings about managerial problem solving approaches will be also incorporated as such Redips can be widely adopted.

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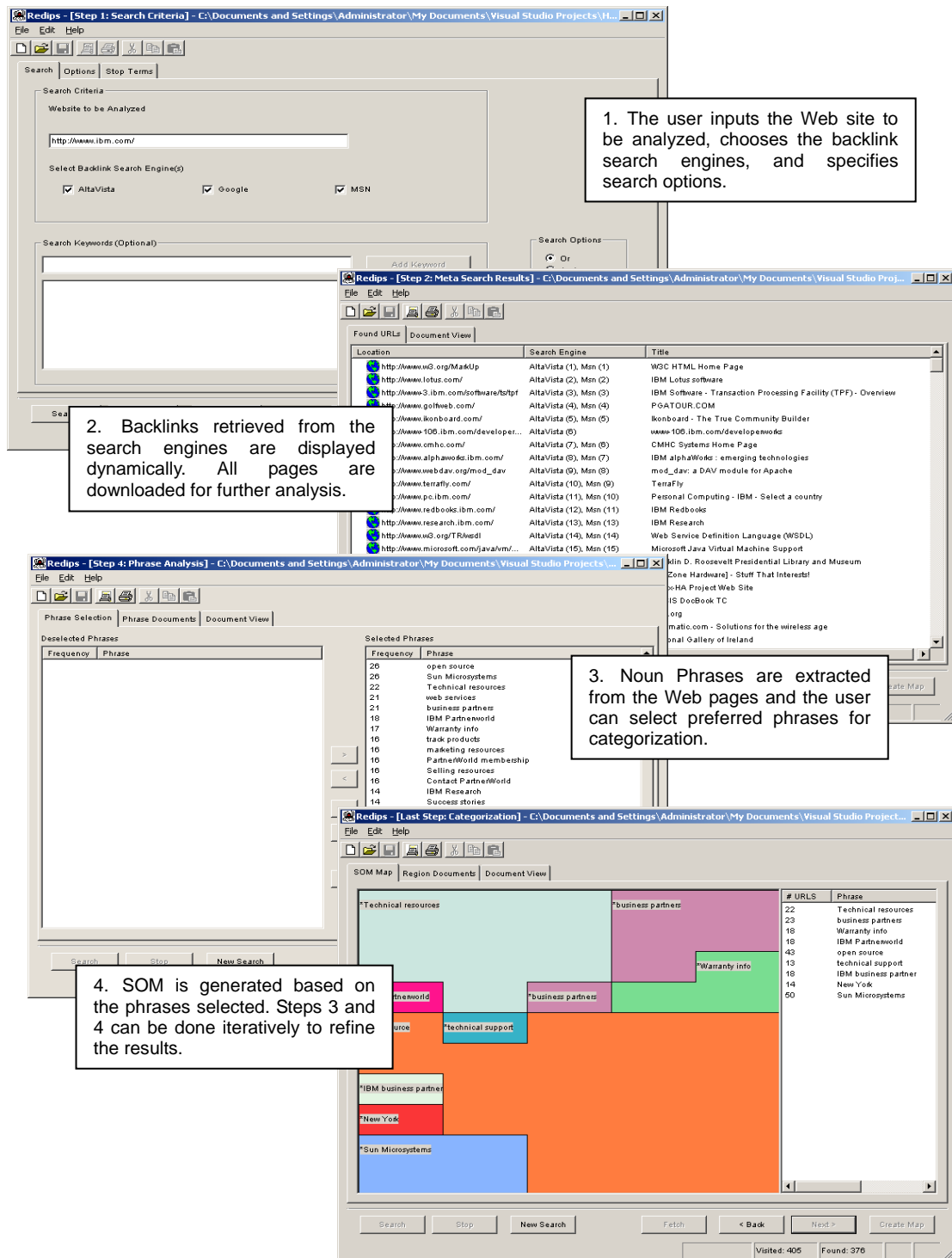


Figure 1: Example of a User Session with Redips

Using Header Session Messages to Filter-out Junk E-mails

Chih-Chien Wang, Sheng-Yi Chen
Graduate Institute of Information Management
National Taipei University

Abstract: Due to the popularity of Internet, e-mail use is the major activity when surfing Internet. However, in recent years, spam has become a major problem that is bothering the use of the e-mail. Many anti-spam filtering techniques have been implemented so far, such as RIPPER rule learning algorithm, Naïve Bayesian classifier, Support Vector Machine, Centroid Based, Decision trees or Memory-base filter. Most existed anti-spamming techniques filter junk e-mails out according to e-mail subjects and body messages. Nevertheless, subjects and e-mail contents are not the only cues for spamming judgment. In this paper, we present a new idea of filtering junk e-mail by utilizing the header session messages. In message head session, besides sender's mail address, receiver's mail address and time etc, users are not interested in other information. This paper conducted two content analyses. The first content analysis adopted 10,024 Junk e-mails collected by Spam Archive (<http://spamarchive.org>) in a two-months period. The second content analysis adopted 3,482 emails contributed by three volunteers for a one week period. According to content analysis results, this result shows that at most 92.5% of junk e-mails would be filtered out using message-ID, mail user agent, sender and receiver addresses in the header session as cues. In addition, the idea this study proposed may induce zero over block errors rate. This characteristic of zero over block errors rate is an important advantage for the anti-spamming approach this study proposed. This proposed idea of using header session messages to filter-out junk e-mails may coexist with other anti-spamming approaches. Therefore, no conflict would be found between the proposed idea and existing anti-spamming approaches.

Keywords: Web Intelligence and Web Based Information Technology, Spam, Unsolicited E-mail, Junk E-mail, E-mail Address, Filter

I. Introduction

Internet grew vigorously fast and is now a necessary of daily life for many people. According to eTForecasts's statistics, the number of Internet users in the world will surpass 1 billion in mid 2005 and the U.S. continues to lead with over 185 mill Internet users for year-end 2004[11]. According to report conducted by Center for the Digital Future at University of South California Annenberg School, the time American Internet users spend on Internet a week grew from 9.4 hours in 2000 to 12.5 hours in 2003[5]. That is to say,

surprisingly, American Internet users spend on Internet up to 1.78 hours everyday. In the year 2000 to 2003, the growth rate of time spending on Internet is 33%. Therefore, Internet has become an important role in people's life.

The survey conduct by Center for the Digital Future at University of South California Annenberg School also indicated that the Internet activity American Internet users the most do is E-mail and instant message, about 90.4% [5]. So, using E-mail is the major activity when surfing Internet. However, spam problem critically influences every Internet users' life and wastes huge resources include network bandwidth and disk storage. Obviously, existence of junk e-mails is an irritating problem when using Internet. Nine out of ten e-mails in America are spam and 76% of all e-mails globally are spam, according to Sharon Gaudin (2004) [26] [27]. The spam problem is going to get worse if we do not put effort on anti-spamming.

Jon Postel, an Internet pioneer, recognized the potential of junk e-mail problem as long ago as November 1975 and proposed Requests for Comments (RFC) 706 that draw up the problem for junk e-mail [17]. In 1982, ACM president Peter J. Denning [21] published the first article about junk e-mail on Communications of ACM. He indicated that junk e-mail will abound in E-mail mailbox. However, "Spam" word became wide-spreading in April 1994, two American lawyers named Canter and Siegel hired a programmer to write a simple script to post their advertisement to every newsgroup board on USENET in order to propagate their U.S. "green card" lottery service [19]. After this event, some people identified it as "Spam" and the word caught on. This event can be called the beginning of spam.

Many studies aimed at spamming, for example, Damiani et al. presented a peer-to-peer architecture between mail servers to collaboratively share knowledge about anti-spamming [10]. Jung and Sit focused on DNS black lists [14]. Sahami et al. applied Bayesian approach to filtering junk e-mails out [20]. Rigoutsos and Huynh presented a Chung-Kwei algorithm based on Genetic algorithm to implement a system for the analysis of junk e-mail [13]. Leiba and Borenstein found no one technique solves the spam problem fully, but different techniques excel in different ways and he present using multiple techniques in several layers in order to promote filtering effect [3]. Golbeck and Hendler presented an e-mail scoring mechanism based on a social network augmented with reputation ratings [15]. Goodman focused on the sender's IP address that cannot be faked, so it is a key for anti-spam [7].

The existed techniques could not filter out all spam emails. Spammers might find way to avoid filter out. Junk e-mails may contain faked sender's e-mail address, send in

small batch, and with subjects irrelevant with mail contents to avoid being filtered by anti-spamming mechanisms. Therefore, more efforts are needed to improve current anti-spam techniques.

In addition, some filtering technique may result in a high rate on filtering spam out, but simultaneously cause a high rate on over-blocking normal e-mails. For example, some anti-spamming mechanism might filter out e-mails containing the word "adult" although these solicited e-mails are for "adult continue education" and are sent to or by a scholar majoring in this field. Moreover, a manager might want to e-mail a message to all employees, such bulk e-mails might also be filtered by anti-spam mechanism. At these two situations, the anti-spamming mechanisms have a high over-blocking rate.

Over-blocking normal e-mails as spamming may induce loss of emails and make email service unreliable. The over-blocking problem may cause users trouble for their daily life or work. Internet users who encounter over-blocking problem may not trust e-mail anymore. People sending out an e-mail have to confirm receiver the delivery of email. This over-blocking problem makes email an inconvenience application.

Most existed anti-spamming techniques are memory-base approaches filtering junk e-mails out according to email subjects and body messages. However, subjects and e-mail contents are not the only cues for spamming judgment. All e-mails have a header session composed of several messages about sender's mail addresses, receiver's mail addresses, mail servers, client e-mail software, message identity number, time stamp, etc. These messages existed in header session may be used as cues for anti-spamming.

Due to the imperfect of existed anti-spamming techniques, more efforts are needed to find new anti-spamming approaches. This paper presents a new idea of filtering junk e-mail by utilizing the header session messages. Besides content and subject, e-mail has a header session containing some fields of messages. Past anti-spamming techniques usually used email subjects or contents as cues for anti-spam filtering and neglected the information in the header session.

Header session is designed for storing messages about e-mail delivery. Usually Internet users do not care messages in the header session expect sender e-mail address for replying e-mail and time stamp for sorting e-mails. Most users are not interested in other information. However, these messages which users are not interested in may be cues for anti-spam filtering.

This study uses message-ID, mail user agent, sender and receiver addresses in the header session as cues for anti-spam filtering. The e-mail addresses of sender and receiver identify sender and receiver. Spammers usually send junk e-mails with invalid sender address to avoid possible accusation and suspension of e-mail service by Internet Service Provider. In addition, most junk e-mails are sent out in bulk. Spammers usually put receivers' emails in the field of blind carbon copy and do not reveal the real receivers to avoid receivers to know that this e-mail is sent out for

enormous copies. That is, the receivers' e-mail addresses would not be found in receiver and carbon copy receiver field for most junk e-mail.

X-Mailer field of header session indicates what client software or mail user agent (MUA) was used to send the e-mail out. Normal personal communication e-mails are sent out via client software such as outlook, outlook express, lotus note, and so on. However, junk e-mails are sent out via bulk email software. These bulk email software may not point out their software name in the X-Mailer field or randomly put unmeaning characters in the X-mailer field.

Message-ID field is generated either by the MUA or by the first mail transfer agent (MTA) the message passes through, uniquely identifying a piece of e-mail. Most spammers would fake the part value of Message-ID field and cause the domain name of sender address not match the domain part of message-ID. Spammers hope to avoid revealing the real domain name of the MUA or the first MTA the message passes through and thus add a fake domain name to Message-ID field.

The rest of this paper is organized as follows. In the following sections, this paper introduces reviews on anti-spamming mechanisms and efficiency of anti-spam techniques. Then, research design is presented and the results of content analysis are detailed. Finally, we discuss the possibility of using the header session messages as cues for anti-spam filtering. The results of this study indicated that these header session messages might be useful in screening out junk e-mails.

II. Anti-Spamming Approach

The rapid increase in spam traffic took a bothering problem to end users and business corporations. However, a number of methods have been proposed to filter spam out. However, these anti-spamming methods had a very limited effect so far. Various techniques for filtering spam are listed below.

II.1 Bulk E-mail Filtering

Bulk e-mail filtering is the easiest filtering technique that filters bulk e-mail out for mail server. This method is based on the assumption that junk e-mail are generally sent to a large number of recipients, so system administrator only need to set an upper limit for recipients of every e-mail at mail server. However, spammer can easily avoid this filtering technique by changing the e-mail header information constantly after sending a certain number of e-mails. In addition, this method may easily filter out important e-mail that includes a large number of recipients. The key determinant of this method's efficiency is recipients' upper limit setting. If setting is too strict, this filtering technique would easily filter out the normal e-mails. On the contrary, setting too loose would make junk e-mail not be filtered out.

II.2 Filtering by Keyword

Keyword filtering is the most frequently used anti-spamming

technique. There are two approaches for this method. The first one is an easy but inefficient approach which sets keyword and filter out all e-mails with keyword appeared in subject or content. "On Sale", "Sex" and "Get Rich" are frequent used keyword. However, this method is inefficiency, while spammer would avoid using these keywords and normal e-mails containing these keywords will be mistakenly regarded as junk e-mails.

The second way is to filter out junk e-mails basing on machine learning results. This approach is more complex and more efficient than the former one. In this approach, the keywords are determined by machine learning algorithm and frequency of all keyword is calculated to discriminate junk and normal e-mails. Many studies are based on this approach, such as RIPPER rule learning algorithm (Cohen, 1996[7]; Provost, 1999[22]), Naïve Bayesian classifier (Sahami 1998[24]; Schneider 2003[25]; Sinclair 2004[29]), Support Vector Machine (Drucker et al. 1999[9]; Kolcz and Alspector 2001[18]; Gordon and Hongyuan 2004[12]), Centroid Based (Soonthornphisaj et al. 2002[30]), Decision trees (Carreras and Marquez 2001[4]) or Memory-base filter (Androustopoulos et al. 2000[2]). This method is based on the assumption that the subject or body sector of junk e-mails may contain specific words. However, this technique does not work perfectly, and thus normal e-mails would be filtered out simply because they include too many words on the keyword list for junk e-mails.

II.3 Black List

This approach exploits a black list database to block specific address or domain name of e-mail. Such database is made available on the Internet, such as DNSBLs (<http://dsbl.org/main>) or SORBS (<http://www.us.sorbs.net>). If the database updates frequently, it can be reliable for filtering certain known spammers' address out. However, it is a defect that if mail servers improperly set normal e-mail address or domain name into black lists would filter out normal or important e-mail. Besides, spammers usually leave random assigned faked sender addresses which not in the black list. Black list approach can not function if sender addresses are faked.

II.4 White List

White list is design to avoid filtering normal e-mails out. White lists gather permitted e-mail address or domain name and often collaborate with black lists. Black lists block illegal e-mails address and White lists allow normal e-mails to pass. It is more difficult to maintain the white lists database perfectly than black list.

II.5 Sender Address Validity

In 1982, Crocker revised the Requests for Comments (RFC) 822 that is a standard for the format of ARPA Internet text messages and the format of e-mail is described in. [8] According to RFC 822, each e-mail must include the field of "From" that contains the address of the sender who wished this message to be sent. All e-mails should have at least one sender and the "From" field must be present. Although RFC

822 mandate the existence of the "From" header in e-mails, the sender address can be invalid or faked by spammer. The spammers avoid being accused of sending junk e-mail and breaking the law. Additionally, most Internet Service Providers (ISPs) or e-mail service provides would suspend the use of spammers' e-mail address or refuse to relay the e-mails they sent. According to Wang (2004)'s research, 60.3% junk e-mails provide invalid sender address [31]. Therefore, the validity of sender address left in the "From" header session may be a cue for anti-spam filtering.

II.6 Receiver Address as Cue

Also according to RFC 822 [8], the receiver addresses are list in the "TO", "CC", or "BCC" fields and like sender address, each e-mail must have at least one receiver. The "TO", "CC", or "BCC" headers are used to present the recipients of this e-mail where to sent. "TO" field contains the identity of the primary recipients of the message and "CC" standing for carbon copy, contains the identity of the secondary recipients of the message. Thus, the function of the "TO" and "CC" fields are very similar. However, "BCC" differs from "TO" and "CC". "BCC" standing for Blind Carbon Copy, contains the identity of additional recipients of the message. The contents of this field are not included in copies of the message sent to the "TO" and "CC" recipients. According to Wang's research, only 7.2% spam would put receiver address in "TO" or "CC" and spammer usually use the "BCC" for the receiver address to avoid revealing that junk e-mail are sent in bulk.[31] Hence, the presence of receiver address left in the "TO" or "CC" header session may be a cue for anti-spam filtering. However, this approach may filter out normal e-mail while people use the "BCC" for the receiver address to send normal e-mails.

II.7 Mail User Agent as Cue

In header session, RFC 822 notes the use of X- at the beginning of field names to indicate that a field is an extension. The X-Mailer field indicates what e-mail client program or MUA was used to generate the e-mail. Although this field is not required in header session, most MUA developers generally have their software add an appropriate X-Mailer field to all out-bound e-mails. According to observation made by this study, most junk e-mail do not include the X-Mailer field or include this field with random assign value. Therefore, the field of X-Mailer may be a cue for anti-spam filtering. Most frequent used MUAs, for example, Outlook Express, MS Outlook, Lotus Note or Eudora etc., marked X-Mailer field of out-bound e-mails exactly. On the contrary, an inbound e-mail that X-Mailer field value is null, meaningless random assign value may mean that this e-mail is probable junk e-mail. A normal MUA for sending bulk e-mail would not fake the X-Mailer field because feigning it as Outlook Express, MS Outlook, Lotus Notes, or some other MUA software may violate the trademark law although developing bulk e-mail software do not violate any law. As a result, the X-Mailer field can be a cue for ant-spam filtering.

II. 8 Message-ID as Cue

The unique message identifier in the header session is generated by the MUA or by the first MTA the message passes through if MUA did not yet assign one for the e-mail. This identifier is intended to be machine readable and not necessarily meaningful to humans. The format of this message ID field value is with a symbol of “@” dividing the value into two parts. The left side contains a string of characters to uniquely identify the message on the machine where it was created and is usually based on the date and time or depending on the e-mail software generating the data. The right side specifies that machine or domain name [16: pp. 32-33]. Most spammer would fake this domain value to avoid possible internet service suspend and cause the domain of sender address not match the domain part of Message-ID. Spammers hope to avoid revealing the real domain name of the MUA or the first MTA the message passes through and thus add a not existed domain name. Consequently, this condition provides a cue for deciding the possibility of an incoming e-mail is a junk-mail.

III. Efficiency of Anti-Spam Techniques

While calculating the effectiveness for anti-spam filtering techniques, two types of errors should be taken into consider. First, under-blocking occurs when e-mail is not blocked that should be filtered out. Second, over-blocking occurs when solicited normal e-mail that should not be filtered out is blocked. Shortly, it is bad anti-spamming techniques that junk e-mails are not blocked or normal e-mails are blocked. These two error rate format proposed by Resnick et al. (2004) are listed blow [23].

Under-blocking errors = $\frac{\text{unblocked junk e-mails}}{(\text{blocked junk e-mails} + \text{unblocked junk e-mails})}$

Over-blocking errors = $\frac{\text{blocked normal e-mails}}{(\text{unblocked normal e-mails} + \text{blocked normal e-mails})}$

Reducing both two error rates mentioning above is a good filtering technique should do. However, the importance of under-blocking errors and over-blocking errors is not same. For most e-mail users, the problem of over-blocking errors is more important than under-blocking errors. While encountering unblocked junk e-mails, users only spend additional time on deleting them. However, over-blocking normal e-mails generally can not be recovered. Thus, users would lose some important messages and it may cause troubles at communication for work or daily life. If e-mail users aware the possible risk of over-blocking, they have to ask receiver to confirm e-mail receiving. This may bring inconvenience to e-mail users and make e-mails unreliable.

The under-blocking errors and over-blocking errors are benchmark for effectiveness of anti-spam filtering techniques. However, most past researches focus on the under-blocking errors although it is important to reduce both two error rates for anti-spam filtering. For examples, Chen et al. [6] report that they can filter out 98.54% junk e-mail but

do not mention the over-blocking error rate. Woitaszek et al. [32] report as low as 96.69% under-blocking errors but not mentioning the over-blocking error. The same situations had also found in Ahmed et al.[1], Androutsopoulos et al. [2], Drucker et al. [9], Shih et al. [28] and Soonthornphisaj et al. [30]’s studies.

IV. Content Analysis for Junk and Normal E-Mails

This study conducted two content analyses. The first content analysis (study 1) adopted 10,024 Junk e-mails collected by Spam Archive (<http://spamarchive.org>) in a two-months period. Spam Archive has collected large number junk e-mails that is donated by end users and is a well known large spam repository for developing anti-spam tools. The second content analysis (study 2) adopted 3,482 emails contributed by three volunteers for a one week period. The collected 3,482 emails in study 2 were classified into three categories: normal, junk and solicited listserv and commercial ones. Normal e-mails are e-mail for personal communication. Junk e-mails are unsolicited e-mails and are usually send in bulk and for commercial purpose. However, some emails are solicited for users although they are sent in bulk. Listserv e-mail is a typical case for this category. People may join a listserv, discussion board, or family in yahoo to receive e-mails. In addition, users may subscribe retailing websites to receive updated sale messages. These kinds of listserv and commercial e-mails should be treated as solicited although most of them are sent in bulk.

This study use content analysis to examine the possibility of using header session messages as cues to discriminate normal and junk e-mails. Analyzing fields of sender, receiver addresses, messages ID, and MUA in normal and junk e-mails’ header sessions are used for this purpose.

IV. 1 Sender Addresses

Sender addresses validity was check for all normal and junk e-mails this study collected. The study checked sender addresses via Domain Name Server (DNS) checking for existence of mail server and Simple Mail Transfer Protocol (SMTP) checking for existence of mail account. Each sender’ email account was check if the SMPT servers refused to response to email addresses validity checks. Figure 1 and 2 indicates the sender address checking results of study 1 and 2. Of the 10,024 junk e-mails study 1 collected, 6,664 (66.48%) were with invalid sender addresses. Of the 2,248 e-mails study 2 collected, 791 (35.1%) were with invalid sender addresses. Of the 635 solicited listserv or commercial e-mails study 2 collect, only 28 (4.41%) were with invalid sender addresses. Moreover, none (0%) of normal e-mail study 2 collected was with invalid address.

The results of sender address validity checking showed that sender address may be a cue for reduce over block rate.

As figure 2 indicated, all normal e-mails were with valid sender addresses. This means that there is no side effect, no normal email will be mistakenly block out, if we filter out all e-mails with invalid sender addresses. Simply filter out e-mail without valid sender addresses may block out 66.48% junk e-mails in study 1 and 35.1% junk emails in study 2. However, 4.41% solicited listserv or commercial e-mails in study 2 will also be filter out according to this valid sender address rule. This 4.41% filtered emails might be regarded as over block e-mails if we treat solicited listserv and commercial ones as normal. Nevertheless, the over block rate will be zero if users think that it is acceptable to filter out listserv and commercial e-mails.

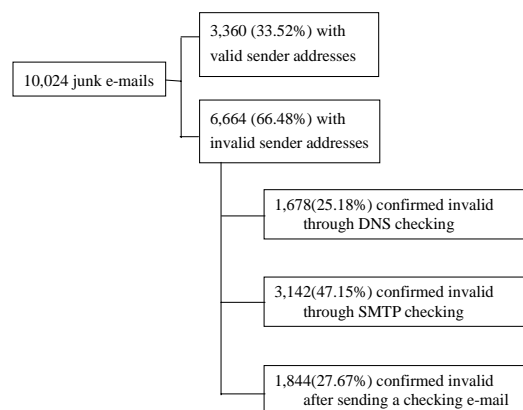


Figure 1: Sender Address Checking for Study 1 (10,024 Junk e-mails)

IV. 2 Receiver Addresses

Presence of receiver address left in the “TO” or “CC” header session may be a cue for anti-spam filtering since that spammer usually use the “BCC” for the receiver address to avoid revealing that junk e-mail are sent in bulk. [31]

All receiver addresses of junk e-mails collected by spamarchive.org are omitted. So this study cannot analyze the receiver addresses of junk e-mail in study 1. The figure 3 indicated the content analysis results of receiver addresses in study 2.

It is showed that 84.64% normal e-mails containing receivers' address in “TO” and “CC” fields while 15.36% normal e-mails without receivers' address in “TO” and “CC” fields. In addition, 44.26% junk e-mails and 11.81% solicited listserv and commercial e-mails were with receivers' address in “TO” and “CC” fields while 55.74% junk e-mails and 88.19% solicited listserv and commercial e-mails without.

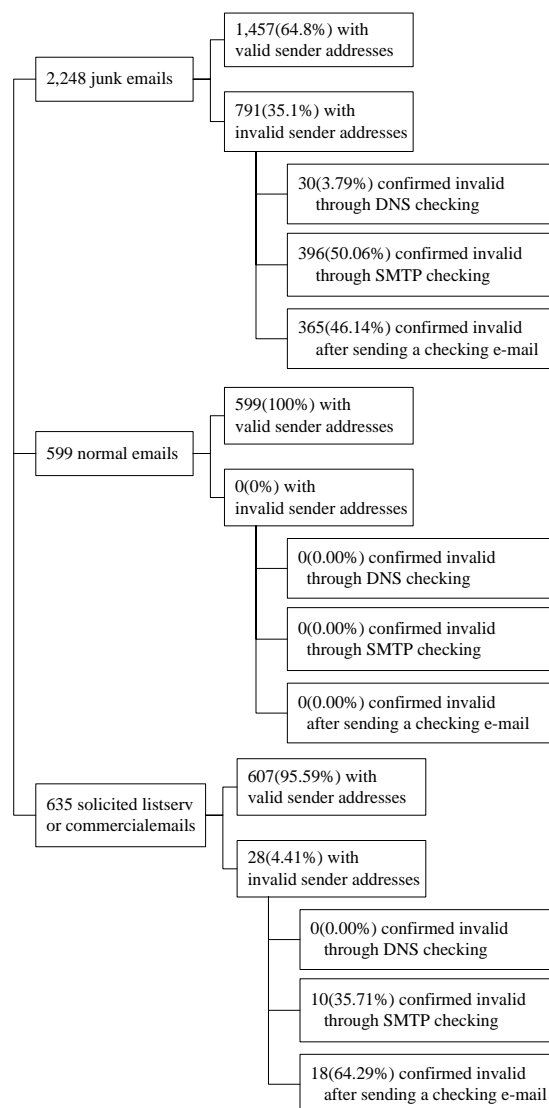


Figure 2: Sender Address Checking for Study 2 (3,482 normal, junk and solicited listserv and commercial e-mails)

Receiver address could be used as a cue for normal e-mail judgment. If an e-mail is with receivers' address in “TO” and “CC” fields, the possibility of this e-mail is normal e-mail is high. However, this should be an assist cue since that some normal e-mails purposely put receiver' e-mail addresses in the “BCC” header session.

The high block out percentage for solicited listserv and commercial e-mails are from the fact that most listserv and commercial e-mails are sent in bulk. It stands to reason to put receiver's addresses in “BCC” rather than “TO” or “CC” fields if e-mails are sent in bulk. Over block some normal e-mails (15.36%) and most solicited listserv and commercial e-mails (88.19%) are side effect of using receiver addresses to filter out e-mails. However, since that most normal emails were with receiver addresses in “TO” or “CC” fields, receiver addresses may still be assist cues for normal e-mails. In addition, receiver addresses may still be useful in anti-spamming if it is acceptable for users that over-blocking

solicited listserv and commercial e-mails.

IV.3 Mail User Agent

Mail User Agents (MUAs) are e-mail client programs used to generate the e-mail. Most normal e-mails were with X-mailer messages to present the MUA which sent the e-mails although this is not required. However, most junk e-mails do not include the X-Mailer field or include this field with random assign value.

Figure 4 and 5 indicated the content analysis results of X-mailer field. The results showed that 1.73% junk e-mails in study 1 and 4.34% junk e-mails in study 2 were sent by frequent used bulk e-mail programs. In addition, no X-mailer messages found in 58.21% junk e-mails in study 1 and 55.05% in study 2, respectively. 5.69% junk e-mail in study 1 and 9.75% in study 2 were with random assigned value for X-mailer field. 2.03% junk e-mail in study 1 and 2.75% in study were sent by infrequent used MUA.

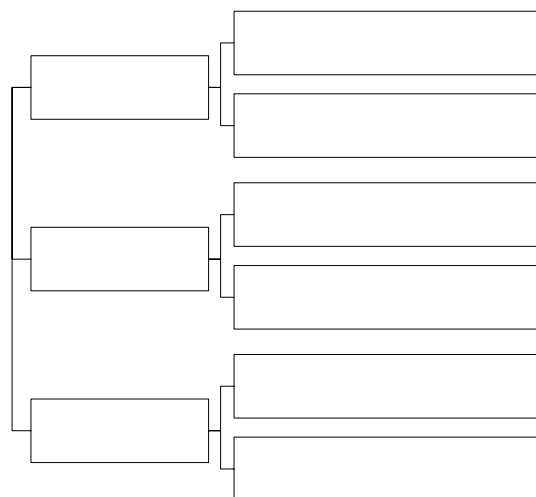


Figure 3: Receiver Addresses of Study 2

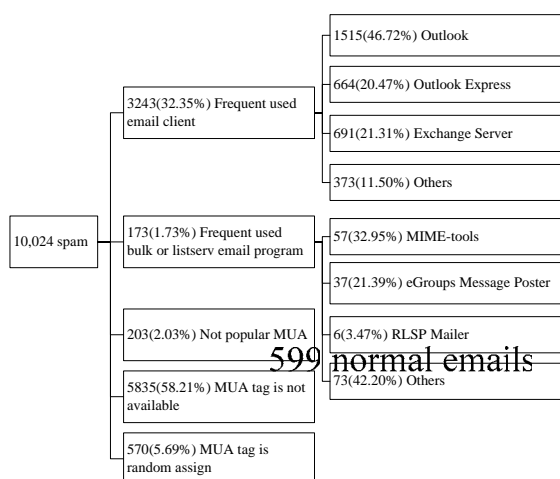


Figure 4: MUA for Study 1 (10,024 Junk e-mails)

Moreover, most normal e-mails (52.96%) in study 2

2,248 junk emails

were sent by frequent used MUA program as figure 5 indicated. Only 2.44% normal e-mails in study 2 were sent by bulk e-mails program, 0.87% by infrequent used MUA, 0.00% with random assign X-mailer value, and 43.73% were without X-mailer message.

As content analysis results point out, MUA could be used as a cue for normal e-mail judgment. The possibility of the e-mail is normal one is high if an e-mail is with frequent used MUA. On the contrary, the possibility of the e-mail is junk one is high if e-mails are sent by bulk e-mail program or the X-mailer messages are random assigned. However, this should be an assist cue since that normal e-mails send by web mail interface may have similar characteristics of X-mailer field.

IV.4 Message-ID

Message-ID is generated by the MUA or by the first MTA the message passes through if MUA did not yet assign one for the e-mail. This may be used as a judgment cue for normal e-mail. Most spammers hope to avoid revealing the real domain name of the MUA or the first MTA the message passes through and thus add a not existed domain name. So, if the sender addresses match the domain name specific in message-ID, the possibility is high of the e-mails are normal ones. However, it is not definitely junk email if the message-ID does not match sender address since that message-ID may be assign by MUA rather than MTA. If message-ID is assign by MUA such as outlook express, the computer name rather than e-mail domain name is put in right side of message-ID. Besides, according to the authors' observation, some web mail system put software or computer name rather than domain name to right side of message-ID. This also makes the not-match between message-ID and sender address.

Figure 6 and 7 indicated the analyze results of match between message-ID and sender Address. The results showed that message-IDs did not match sender address for 82.66% junk e-mails in study 1 and 39.32% junk e-mails in study 2. However, only 11.02% message-IDs of normal e-mails in study did not match sender addresses.

V. Using Header Session Message to Anti-Spam

As mention above, sender address, receiver address, MUA, and message-ID could be used as cues for anti-spamming. If sender address or receiver address is not found in "TO" and "CC" fields, the possibility is high of the e-mail is junk, as figure 3 pointed out. Besides, as figures 4 and 5 indicated, the possibility is high of an e-mail is sent in bulk if MUA is bulk e-mail program. MUA tag is not available, or is random assign. In this situation, the e-mail may be junk and should be filter out. Moreover, if message-ID does not match sender address, the possibility is high that the message-ID is

995(44.26%) contain receiver's address in "TO" and "CC" fields

1253(55.74%) without receiver's address in "TO" and "CC" fields

assigned by MUA rather than MTA or message-ID is faked to avoid possible trace. Some frequent used MUA programs, such as outlook express and some webmail programs, assign Message-IDs to all send-out e-mails base on their own rules irrelative to sender's address so that the Message-ID would not match senders' address. However, if an e-mail is not send by these kinds of MUA, the message-ID should match sender's address. If not match, the possibility is high of the e-mail is junk, as this study found in figure 6 and 7.

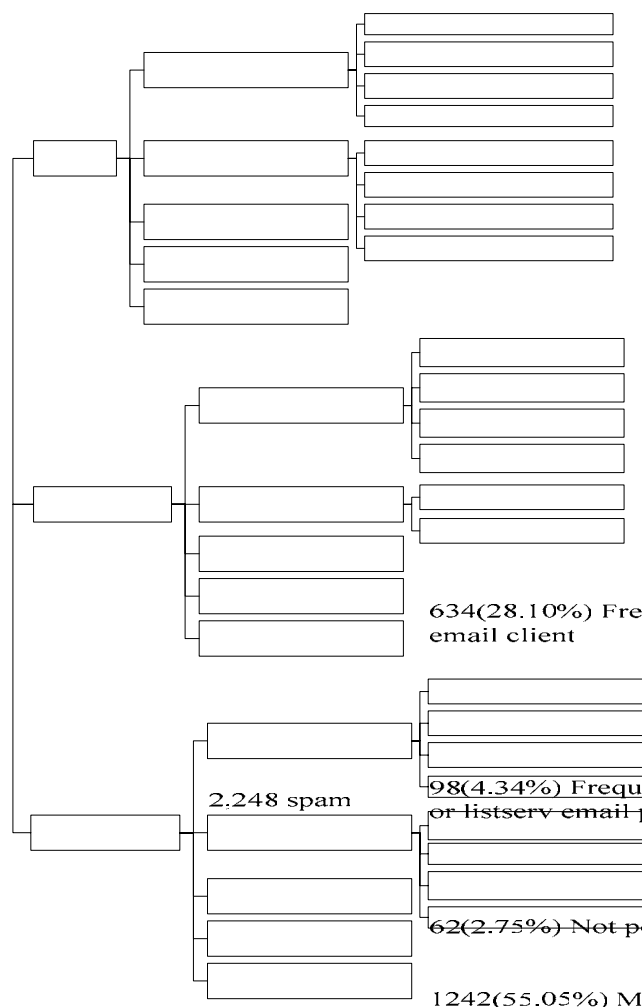


Figure 5: MUA for Study 2 (3,482 normal, junk and solicited listserv and commercial e-mails)

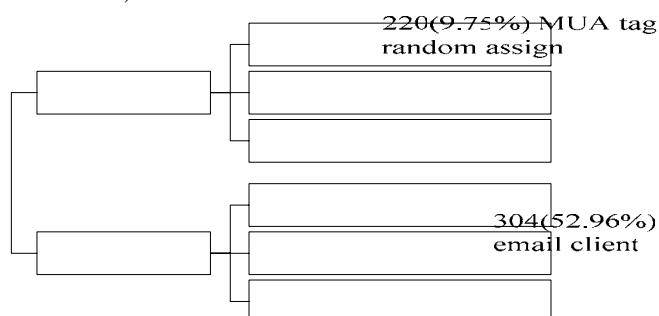


Figure 6 Match between Message ID and Sender Address for junk e-mails

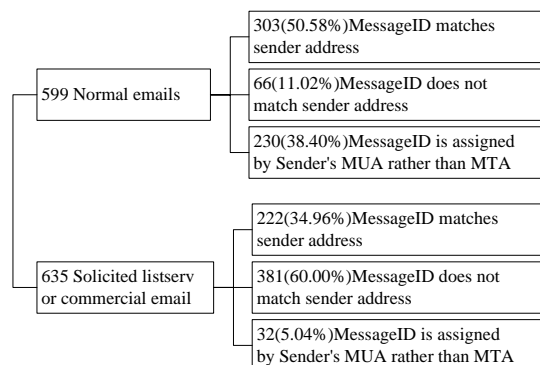


Figure 7 Match between Message ID and Sender Address for normal and solicited e-mails

Sender address, receiver address, MUA, and message-ID can not to be used alone for anti-spamming. If we simply filter out an e-mail without receiver address in "TO" and "CC" fields, we may over block some normal e-mails which is sent purposely by blind carbon copy. The similar situation will also be found in using MUA and message-ID as anti-spamming cues. Image the situation that a user hopes to send a personal notify to her or his friends in a large batch, he may adopt bulk e-mail MUA. Filter out e-mails send out by bulk e-mail MUA will also over block this kind of e-mails which should be treat as normal rather than spam. The same situation will happen for message-ID. It still could be normal e-mail when message-ID does not match sender's domain name. Some SMTP components, modules and libraries for website programming do not consider well about message-ID tag. For those users who use these kinds of MUA, message-IDs would not match senders' addresses, even what these users send out are normal emails.

This study proposed a combined anti-spamming judgment approach since single item of sender address, receiver address, MUA, and message-ID can not be used as the only cue for anti-spamming. This anti-spamming approach judge e-mails as normal or spamming according to four cues, i.e. sender address, receiver address, MUA, and message-ID. An e-mail will be judge as normal if it conform the rules of normal e-mail. Nevertheless, it will be judge as junk when conform the rules of junk. If an e-mail conform the rules of normal e-mail, the e-mail will be classified as indeterminate. Filter or not this kind e-mail should be user's personal choice.

Table 1 indicated the anti-spamming approach this study proposed. The possibility is high of an e-mail is not spam if it is with valid sender address, MUA is not frequent used bulk or automated email program, and Message-ID matches sender address or is assigned by MUA rather than sender's MTA.

However, if an e-mail is probably sent by bulk e-mail program, Message-ID does not match sender address, is carbon copy to receivers, and with invalid sender addresses, the possibility of the e-mail is junk.

Qualifications for spam rules mentioned in table 1 are too strict. An e-mail could still be spam if it does not reach

574 normal emails

14(2.44%) Frequent used bulk or listserv email program

10(71.47%) MIME-tools

4(28.57%) Epaper Boy

5(0.87%) Not popular MUA

251(43.73%) MUA tag is not available

0(0.00%) MUA tag is random

all four rules mention in table 1. This study proposed an idea that an e-mail will be regarded as spamming if with invalid sender address or if it matches two of remain three rules, rules 2, 3 and 4, of table 1. This study advocated that rule 1, invalid sender address, is enough to filter out an e-mail although some listserv e-mails will be mistakenly filter out. It is unreasonable to send an e-mail with valid sender address even if it is sent automatically.

Table 2 and 3 indicated the anti-spamming results of study 1 and 2. The junk e-mail filter out rate for study 1 is 79.11% if we filter out the e-mails which are judged as spam. However, this rate will raise 13.39% to 92.50% if filtering out e-mails which are judged as indeterminate and keep only e-mails which are judged as normal. For study 2, the junk e-mail filter out rate is 75.66% if we filter out the e-mails which are judged as spam. This filter out rate will raise 2.97% to 78.63% if filtering out e-mails which are judged as indeterminate. However, the anti-spamming approach this study proposed filtered out 88.50% solicited listserv and commercial e-mails. This rate would increase 2.76% to 91.26% if filter out e-mails which are judged as indeterminate. Most solicited listserv and commercial e-mails look like junk e-mails. The proposed anti-spamming approach would filter most of them, 88.50%, as table 3 indicated.

Table 4 summary anti-spam efficiency of the approach this study proposed. If a user who hope to filter out junk e-mails as many as possible, he can choose to keep only e-mails which are judged as normal and filter out both spam and indeterminate. This may be named as stick filter. However, some normal e-mails are judged as indeterminate as table 3 indicated. Users have to accept the risk of mistakenly filtering normal e-mails out. On the contrary, users may choose a safe strategy and filter out only e-mails which are judged as spam. In this situation, all normal and indeterminate e-mails are kept. This may be named as slack filter since that only confirmed spam are block.

The over block errors rate reflect the phenomenon that normal e-mail that should not be filtered out is blocked. It is not available for study 1 since that study 1 containing spam e-mails only. The block errors rate is zero if slack filter is adopted for study 2. This means that there is no side effect if slack filter is adopted. No normal e-mails would be filtered out mistakenly. However, the under block errors rate of slack filter is high when comparing with stick filter. The under block errors rate would reduce from 20.89% to 7.50% in study 1 and 24.34% to 21.37% in study 2, if stick rather than slack filter is adopted. This means that 92.50% junk e-mails in study 1 and 78.63% in study 2 would be blocked. Meanwhile, over block errors rate would increase from zero to 10.28%. It is users' own choice that adopting slack or stick filter.

VI. Discussion

Spam is one of the most important problems which going to get worse. Many studies aimed at spamming. However, the

existed techniques could not filter out all spam emails. More efforts are need to improve current anti-spam techniques.

Most existed anti-spamming techniques filter junk e-mails out according to e-mail subjects and body messages. However, subjects and e-mail contents are not the only cues for spamming judgment. This paper presents a new idea of filtering junk e-mail by utilizing the header session messages.

According to content analysis results, this study found that message-ID, mail user agent, sender and receiver addresses in the header session as cues for anti-spam filtering. At most 92.5% of junk e-mails would be filtered out using message-ID, mail user agent, sender and receiver addresses in the header session as cues.

Besides, some filtering technique may cause a high rate on over blocking normal e-mails. Over-blocking normal e-mails may induce lose of normal emails and make email service un-reliable. However, the idea this study proposed may induce zero over block errors rate if slack filter is adopt. This characteristic of zero over block errors rate is an important advantage for the anti-spamming approach this study proposed.

Some may argue that the filter out efficiency is not too high of anti-spamming approach this study proposed. Some studies may have filter out rate of as high as 98.54% [30] or 96.69% [31]. However, the anti-spamming approach this study proposed is a supplementary rather than a replacement for other filter out techniques. This proposed idea of using header session messages to filter-out junk e-mails may coexist with other anti-spamming approaches. No conflict would be found between the proposed idea and existing anti-spamming approaches.

Acknowledgment

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Table 1 Anti-Spamming Approach using sender address, receiver address, MUA, and message-ID

Judgment	Approach	Rules
Judged as Normal E-mails	Do not filter out e-mails containing all three characteristic	Normal email has following characteristics. 1. Valid sender address. 2. MUA is not frequent used bulk or automatic e-mail program. 3. Message-ID matches sender address or is assigned by MUA rather than sender's MTA.
Judged as Spam	Filter out e-mails which match spam rule 1. Or match two rules of rules 2, 3, and 4.	Spam has following characteristics. 1. Invalid sender address. 2. E-mail is not send to or carbon copy to receiver. 3. Sender's MUA is bulk email program or MUA tag is not available or random assign. 4. Message-ID does not match sender address.
Judged as Indeterminate	Neither normal or spam e-mails	Neither normal or spam e-mails

Table 2 Anti-Spamming Results for Study 1

Judgment	Actually Spam		
	Normal	752	7.50%
	Indeterminate	1342	13.39%
	Spam	7930	79.11%

Table 3 Anti-Spamming Results for Study 2

Judgment	Actually						
	Normal E-mails		Solicited Listserv and Commercial E-mails		Spam E-mails		
	Normal	515	89.72%	57	8.74%	482	21.37%
	Indeterminate	59	10.28%	18	2.76%	67	2.97%
	Spam	0	0.00%	577	88.50%	1707	75.66%

Table 4 Anti-Spam Efficiency - Over and Under Block Errors

		Slack filter		Stick filter	
		Filter out E-mails judged as spam		Filter out E-mail judge as spam and indeterminate	
Over block errors rate = blocked normal e-mails / (unblocked normal e-mails + blocked normal e-mails)	Study 2	0.00%		10.28%	
Under Block errors rate = unblocked junk e-mails / (blocked junk e-mails + unblocked junk e-mails)	Study 1	20.89%		7.50%	
	Study 2	24.34%		21.37%	

An Adaptive Interface for Customer Transaction Assistant in Electronic Commerce

Chien-Chang Hsu, Zhen-Han Kuo
Department of Computer Science and Information Engineering,
Fu-Jen Catholic University
510 Chung Cheng Rd., Hsinchuang, Taipei, TAIWAN 242

Abstract: Personalized service and adaptive interface play important factors in electronic commerce. This work proposes an adaptive interface to for helping the customer transaction in electronic commerce. The adaptive interface collects the consumer behaviors by monitoring the customer operations, excluding unnecessary operations, and recognizing the behavior patterns. The interface uses the Bayesian belief network and the RBF neural networks to achieve the above tasks. The interface then evaluates knowledge and skill proficiency according to the customer behavior patterns. Finally, the interface generates the adaptive interface to the consumers for helping the transaction process.

Keywords: Web intelligence and web-based information technology, Adaptive interface, Proficiency evaluation

I. Introduction

Electronic commerce (EC) is the business activity that occurs over the electronic network. The customers purchase goods or services through the business platform of the EC systems. Personalized service and adaptive interface become the important factors to attract their customers. They should provide a friendly environment for the customer to buy goods according to the past consuming behaviors. Customer transaction behavior analysis becomes the important function in the system. Many systems have been proposed for applying the past user transaction history to different applications [3] [7] [8] [9] [10] [11] [13]. These systems are insufficiently specific regarding the analysis of the customer behavior. The system also did not provide the interaction activities analysis for effective customer behavior analysis. Some interface usability tools or systems were designed to overcome the above shortcomings [1] [2] [5] [6] [12]. Many problems still need to be solved. First, most systems use a resident monitoring program in the application system to collect user information from the interaction information between the end user and application system. The monitoring of user behaviors usually uses the cookies and the log files to record the user operations [5] [12]. Cookies were used to keep the user information in the client side. The drawbacks of cookies contain the limited amount of the information in the client side and the dangerous of information loss in the business session. Moreover, the

drawbacks of log files include the collection of passive user request information and the complexity of interaction events. Second, most systems acquire the static and specific business information from the content of the web pages. They do not analyze the interaction operations of the user in the applications. Third, most systems assume the user is an experimented operator and may not commit wrong operations. The collected data are presumed correct and valid information. Finally, most systems lack the customer proficiency evaluation to provide an adaptive interface in the application domain.

This work proposes an adaptive interface for customer transaction assistant in electronic commerce. The system uses the customer transaction behaviors to provide an adaptive interface and transaction guidance. The interface analyzes the transaction behavior and excludes unnecessary operations by Bayesian network. The interface then uses the RBF neural networks to discriminate the behavior patterns based on customer operations. Finally, the interface evaluates the knowledge and skill proficiency of the consumer to provide the intelligent assistant. The interface provides three assistant functions for the customers based on the fuzzy degree of the knowledge and skill proficiency. The interface also provides guidance for the customer to complete the transaction.

II. System Architecture

The system architecture contains two modules, namely, interface manager and behavior analyzer (Fig. 1). The interface manager collects the interactions performed by the customer in the client-side and server-side. It captures the customer interactions from the browser and EC server and filters the customer operations from the customer interactions and recognizes the behavior patterns. It uses the Bayesian belief networks to exclude redundant and irrelevant operations. It then uses the RBF neural network for discriminating the customer behavior from the interaction message

The behavior analyzer uses the behavior patterns to evaluate the knowledge and skill proficiency degree of customer. The former uses the personal ontology and the latter uses the usefulness, precision, dependency, and efficiency measurements to evaluate the consumers. Finally, the interface provides three assistant functions for the customers based on the above evaluation to guide the customer for completing the transaction.

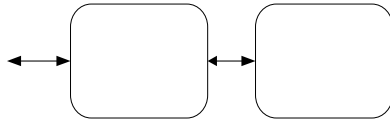


Fig. 1 System architecture

III. Interface Manager

The interface manager is responsible for collecting the transaction behavior and recognizing behavior patterns. First, the interface manager collects Customer operations performed by the customer in the client-side and server-side. First, the interface manager captures the customer interactions from the browser and EC server. Fig. 2 shows the interaction pattern of the system. The interface manager then filters the customer operations from the customer interactions and recognizes the behavior patterns. It uses the Bayesian belief networks to exclude redundant and irrelevant operations. Redundant operations are those which the customer use the same operation for the same subtask. The irrelevant operations are those that are not effective in performing the subtask. The directed acyclic graph is used to represent the relationship among customer operations (Fig. 3). The circular node represents the operation of the customer and the link represents the relationship between operations. Both of two operations $\langle O_1, O_2 \rangle$ and $\langle O_3, O_4 \rangle$ can use to do the same subtask ST_1 . If the customer operates sequence is O_1, O_3, O_2 and O_5 . The operation O_5 is the irrelevant operation and O_3 is the redundant operation for the subtask ST_1 . The probability of the subtask ST_1 , $P(ST_1) = P(O_1) * P(O_2)$. Redundant and unnecessary operations can be removed by computing the joint probability of the operations according to the causal relations of the Bayesian belief network.

The behavior pattern recognition uses the RBF neural model as the behavior pattern classifier for discriminating the customer behavior from the interaction message. The RBF neural model contains three layers, namely, the input, hidden, and output layers (Fig. 4). Notably, the input layer uses 35 nodes to represent the interaction information. The input of the interaction information includes the interaction events, focus object, request method, and query items. The node number of the interaction information in the input layer is 9, 10, 6, and 10 correspondingly. Each interaction event uses three digits to represent the operation. Table 1 lists the code of the interaction event. The character of the focus object, request method, and query items are encoded following the sequence of the alphabetically. Each character then is normalized into a real number ranging between 0 and 1. For example, the request method of "Get" was coded into (7/26, 5/26, 20/26, 0, 0, 0). The interface manager forwards the behavior patterns for use by the behavior analyzer in customer behavior analysis [4].

IV. Behavior analyzer

The behavior analyzer uses the behavior patterns to analyze

the activities and evaluate the proficiency level of the customer. First, it evaluates the knowledge and skill proficiency degree of customer. The knowledge proficiency degree (KP) evaluates the structure similarity between personal ontology and domain ontology. The KP is evaluated by using internal path length of the personal ontology and domain ontology.

$$KP = \frac{IPL_{Personal}}{IPL_{Domain}} \quad (1)$$

where $IPL_{Personal}$ and IPL_{Domain} are the internal path length of Interface Manager ontology and domain Analyze. The KP is partitioned into three proficiency level, namely, novice, knowledgeable surfer, and expert (Fig. 5). Notably, the personal domain ontology stores the terminology and the relations between them of the application domain which was visited or used by the customer. It is constructed by using the merchandise name contained in the transaction operation [4]. The skill proficiency degree classifies customer's experience into one of the following three levels, namely, novice, skilled surfer, and expert. Figure 6 shows the fuzzy partition of the skill proficiency. Furthermore, the skill proficiency degree (SP) is computed by evaluating the skill measure.

$$SP = F(U, P, D, E) = \frac{U * W_u + P * W_p + D * W_d + E * W_e}{n} \quad (2)$$

where U, P, D, E refer to the measure of usefulness, precision, dependency, and efficient. W_u, W_p, W_d , and W_e are respective weights. The usefulness, U , evaluates the correctness and validity of the customer operations.

$$U = 1 - \frac{\sum_{i=1}^n e_i}{n} \quad (3)$$

where e_i represents the ratios of error or nullify operations, $e_i \in [0, 1]$ and n is the operation number.

Precision, P , computes the average number of operations for completing the tasks.

$$P = \frac{\sum_{i=1}^n t_i}{n} \quad (4)$$

where t_i represents the number of operations to achieve the i th task and n is the task number.

Dependency, D , represents the behavior correlation.

$$D = \frac{\sum_{i=1}^n B_i \Rightarrow B_{i+1}}{n} \quad (5)$$

where B_i and B_{i+1} represent the i^{th} and $(i+1)^{\text{th}}$ behaviors, \Rightarrow represents the sequence relationships, and n is the behavior number.

Efficiency, E , measures the average time of the customer for completing the tasks.

$$E = \frac{\sum_{i=1}^n w_i}{n} \quad (6)$$

where w_i represents the time for completing the i^{th} task and n is the task number.

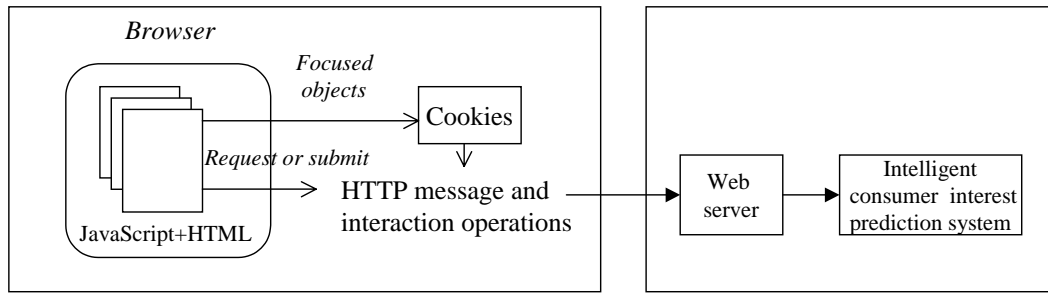


Fig. 2 Consumer interaction pattern

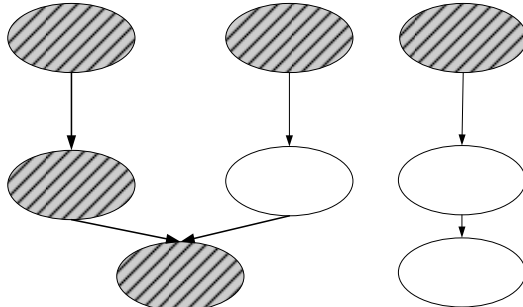


Fig. 3 Bayesian belief network

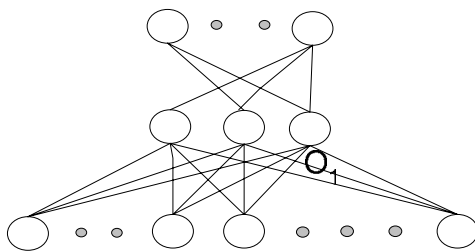


Fig. 4 RBF neural topology

Table 1 Code of the interaction event

Interaction event	Code
Form submission	001
Button clicking	010
Text input	100
Hyperlink clicking	101
Focus object	110
Mouse over	111

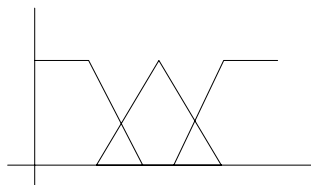


Fig. 5 Fuzzy partition of knowledge proficiency

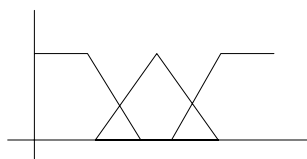


Fig. 6 Fuzzy partition of the skill proficiency

The system uses the values of KP and SP to help the customer for completing the transactions and customizing the interface. The intelligent interface provides three assistant functions for the customers, that is, transaction help, interaction style selection, and control panel expansion. Table 2 lists the assistant functions according to the knowledge and skill proficiency degree of customers. Basically, the transaction help provides three assistant types, namely, personal recommendations, collaborative ranking, and unconstrained transaction, for the customer. The transaction recommendations suggest the most possible merchandises for the customer according to the product hierarchy in the personal domain ontology. The collaborative ranking uses collaborative filtering to rank the possible business transactions for the customers. The unconstrained transaction didn't provide any helps for experienced consumers. The interaction style selection provides three interaction patterns, that is, simple, weak, and strong, for the customers. The simple interaction provides transaction guidance to help the customer in completing the transaction tasks. The weak interaction uses distinct and click-and-selection interface elements, such as menu, radio, and combo buttons, to interact with customers conveniently. Moreover, the strong interaction provides advanced interaction patterns, such as, form fill in and checklists, to interact with experienced customers. Finally, the control panel expansion provides static, semi-adaptable, and fully adaptable interface for customers to insert new control panels in the interface. The static interface provides fixed control panel for the customer who can not modify the web page layout. The semi-adaptable interface provides the panel for the customer to add new personalized icons regarding as the shortcut for doing the transaction. The fully adaptable interface provides the entire control panel for the customer to rearrange the block layout of web page.² Notably, the layout of web pages contains six blocks, that is, EC task bar, personalized icons, transaction behaviors, assistant function, recommendation, and guidance in the sequence of top-left and right bottom (Fig. 7).

V. Conclusions

Behavior patterns

This work presents an intelligent interface for customer transaction assistant in electronic commerce. The system contains two modules, i.e, interface manager and transaction manager. The interface manager extracts the customer

Hidden layer

operations by analyzing the transaction behavior. The exclusion of unnecessary operations uses the Bayesian network to reduce the computation of irrelevant operations. The behavior pattern recognition uses the RBF neural networks to discriminate the behavior patterns based on customer operations. Finally, the behavior analyzer uses the knowledge and skill proficiency evaluation to provide the intelligent assistant. It provides three assistant functions for the customers according the fuzzy degree of the KP and SP. It also provides guidance for the customer to complete the transaction.

Acknowledgement

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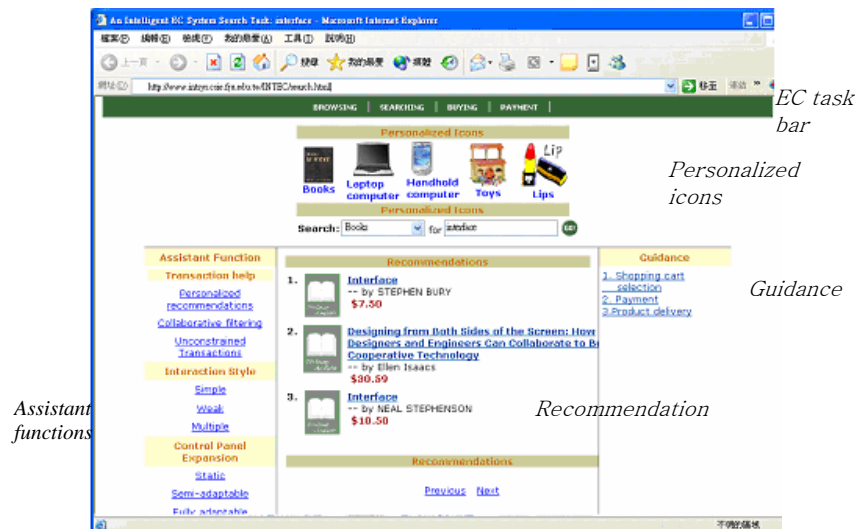


Fig. 7 Novice knowledge and skilled surfer proficiency interface

Table 2 Assistant functions for different knowledge and skill proficiency level

<i>KP</i> \ <i>SP</i>	Assistant function	Novice	Skilled surfer	Expert
Novice	<i>Transaction help</i>	Personal recommendations	Personal recommendations	Personal recommendations
	<i>Interaction style</i>	Simple	Simple	Weak
	<i>Control panel expansion</i>	Static	Semi-adaptable	Semi-adaptable
Knowledgeable surfer	<i>Transaction help</i>	Personal recommendations	Collaborative ranking	Collaborative ranking
	<i>Interaction style</i>	Weak	Weak	Strong
	<i>Control panel expansion</i>	Static	Semi-adaptable	Fully-adaptable
Expert	<i>Transaction help</i>	Collaborative ranking	Unconstrained transaction	Unconstrained transaction
	<i>Interaction style</i>	Weak	Weak	Strong
	<i>Control panel expansion</i>	Static	Semi-adaptable	Fully-adaptable

Question analysis and answering system for the internet usages by using Ontology and Concept Weighting

Narroup Ragngam, Anongnart Srivihok

Department of Computer Science, Faculty of Science, Kasetsart University, Thailand

email: {g4764229, anongnart.s}@ku.ac.th

Abstract: This study proposed a system for an automatic question analysis and answering that applies information extraction techniques for extracting the relevant information from questions of the Internet connections. The study uses both ontology, and concept weighting to extract, and classify questions. The information extractions are divided in two steps as follows. First, ontology is used to create a decision tree according to the concepts of questions. Second, concept weighting is applied; the weight of each concept is given by its frequency in the past documents. The results from this study reveal that it is possible to develop an automatic question answering system. The proposed system had been tested with sample questions from the Internet service provider: True Corporation Call Center. Precision of the system is about 0.77 which is good. This study offers useful information regarding the areas of information extraction for Call Center or Web Based Support Systems.

Keywords: Question analysis; Ontology; concept weighting; Call Center.

I. Introduction

The number of internet usages is increasing tremendously every year. Problems of users with the Internet connections are also increasing. Thus, the Internet Service Provider also needs to help users solve these problems. It is claimed that 80% of internet connection problems are simple and can be solved by users without the assistance of call center. These problems include telephone cord is not plugged tightly, or misspelling password for authentications. In July 2005, the number of phone calls related to internet usage problems in True Corporation which is one of the largest internet service in Thailand are about 71,628 calls. This is huge and these calls consume a lot of service time.

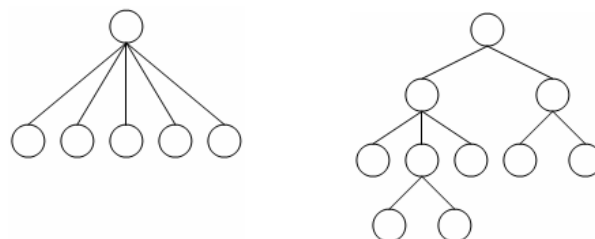
The objective of this study is to offer the proposed question answering systems by using ontology and concept weighting. This study include four main sections. Section 2 is the related theories and studies in the past. Section 3 is research methodology. Last, section 4 is conclusion of the study.

II. Literature Review

II.1 Text Classification

The text are classified by using a classifier which might be

a decision tree. The structure of decision tree can be divided in two categories: hierarchical and flat structure (Figure 1). It was reported that using hierarchical structure for text classification provides higher performance than flat structure [3].



(a) Flat Structure

(b) Hierarchical

Figure 1. Structure of decision trees.

Ontology is a formal, explicit specification of a shared conceptualization [2]. Also, Ontology has been applied in various studies. Miller (1993) introduced WordNet which is an on-line lexical database. This study used ontology for conceptualizing words by lexical order such as verbs or nouns. Wordnet uses semantic in categorising the questions. Yeh and coworker (2003) applied semantic inference on ontology for data mining of medical FAQ. In Thailand, Mounpai and Koatrakul (2003) applied ontology in the classification of One Tambol One Product (OTOP) database which includes large variety of Thai handicrafts and food products.

II.2 Concept weighting

In 2004, Jinarat and Soonthornphisaj [2] used probability method-Naïve Bayes and feature weighting in text classification. The feature weights are changed according to their frequency in the documents. This study reveals that the classifier has better performance after adjusting concept weights. Further, Reinforcement theory is applied in feature weighting of an intelligent agent for tourism. Features are awarded and increased their weights if the user selects the provided trips. On the other hand, they will be penalised by decreasing feature weights if they are not selected. By this way, the weights of trip features are adjusting according to the user selections [7].

II.3 Searching

After the classifier weights are adjusted, then the answers matching for each concepts have been linked. By this way, the customers who want to find the clues for trouble shooting can use the system.

III. Research Methodology

This study presents methods for question analysis and answering system of call center. The system can help customers in trouble shooting of errors in the Internet connections without the assistant of call center. The research design includes four steps (1) question extracting by Latent Semantic Analysis (LSA), (2) Ontology, and (3) Concept weighting. Ontology is applied for classification of concepts in knowledge base and store in hierarchical structure.

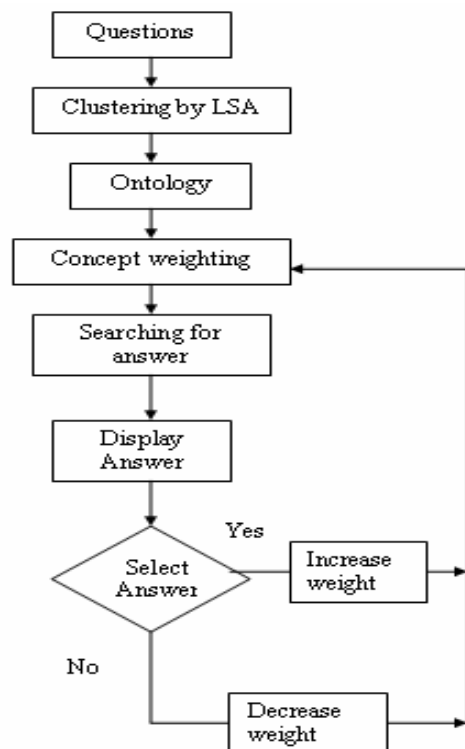


Figure 2: Flow of question analysis and answering system

III.1 Question Extracting

Thai documents are written continuously without stop words or spaces between words. First the questions need to be separated into single words by using Swath program developed by Paisarn (1997). Then Latent Semantic Analysis is applied for solving problems of words which have many meanings namely polynymous and the case of many words which have the same meaning synonym. Then similar words are grouped in one concept. Figure 3 depicts the word synonym.

Word synonymy	Intension
Connect, เชื่อมต่อ, ต่อเน็ต, connected	การเชื่อมต่อ / Connect
ตัด คับ, หลุด, เน็ตตัด, disconnected	เน็ตหลุด / Frequently disconnected
Hisp, high speed internet, ไสปีด, hi speed internet	Hi-speed internet
เออเรอ, Error, Errors	Message Error
....ช้า, เร็ว... k, speed ...MB, slow	ความเร็ว / Speed

Figure 3: Word synonym and grouping

III.2 Document Classification by Ontology

Ontology is applied to build the hierarchical structure classifier. In this study, problems in the Internet connections are classified and built in decision tree which have hierarchical structure (Figure 4). This ontology is developed by the assistant of experts and engineers in the Internet and networking. The problems in internet connections are divided in two main categories: (1) internet can not be connected and (2) internet can be connected but there are some problems. Then each category is divided in subcategories. Each node of the decision tree contains clues or answers which help customers to solve their problems in the Internet connections. Figure 4 reveals the structure of decision tree used in this study.

III.3 Concept Weighting

The frequency of occurrences of each problem is different, thus each concept in the decision tree has different weight. As well, concept weight is depended on the frequency of it occurrence in the Internet connection. From 71,628 calls at call center, about 81% (57,803 calls) complain about unable to connect the Internet. Whereas, the one which can perform the Internet connection still has problems.

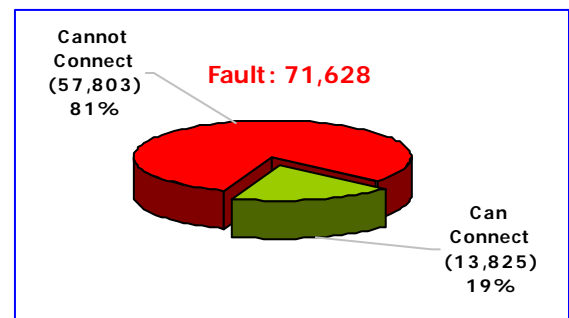


Figure 5: Probabilities of errors in the Internet usages reported at Call Center

Next step is adjusting the concept weights. In this step, each concept will be assigned with a weight according to its occurrence from historical data (Figure 6). For example, the highest frequency of concept which causes internet disconnect is due to no installation of splitter in the computer system which is 42%. The second higher is broken connection line or noise which 21%. Next is connection time out is 19%. Last is virus computer or spyware is 18%.

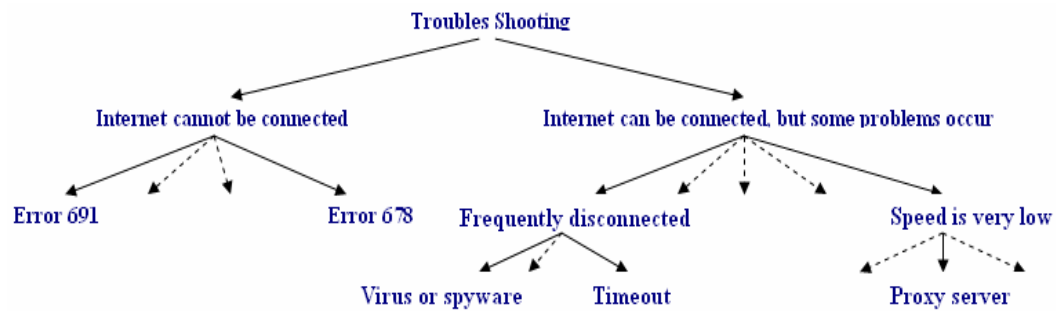


Figure 4: Hierarchical Structure of trouble shooting of the Internet connections

Probability	Cause
0.42	Splitter installation
0.21	broken connection line or noise
0.19	connection time out
0.18	virus computer or spyware

Figure 6: Probability of the cause of the Internet Disconnection

Customer who has problems with internet connection requests for assistants. The system provides answers to customer, then customer responds whether the answers work or not. Customer responses are used in weight adjusting.

Weight Adjustment:

$$W_{ti} = W_{ti} + Q_i$$

W_{ti} = weight of each concept

Whereas Q_i is defined as:

0.1 if user agree that the provided information works

-0.1/n-1 if user does not agree that the provided information works ; n is total number of features

$$\text{Precision} = \frac{\text{Number of correct retrieved answers}}{\text{Total number of retrieved answers}}$$

Example of Weight adjusting for user agrees that splitter installation advice works:

$$W1 = 0.42 + 0.1 = 0.52$$

$$W2 = 0.21 - 0.033 = 0.177$$

$$W3 = 0.19 - 0.033 = 0.157$$

$$W4 = 0.18 - 0.033 = 0.147$$

Figure 7 reveals the advice for splitter installation according to customer requests. Also the system asks for the feedback after customer has solved the problem with the provided information.

Splitter should be installed to prevent disturbing signal during hi-speed Internet access, by following the below instructions.

1. Connect True telephone line to Line socket of the Splitter.
2. Connect telephone line from Phone socket of the splitter to the telephone set.
3. Connect the line from Modem socket of the splitter to the ADSL modem.

[Click here to see how to install splitter](#)

After following the above steps, can the problem of frequent disconnections be solved?

☒ Yes, it can.

☐ No, it cannot.

[Previous](#) [Next](#) [Home](#)

Figure 7. Suggestion by system for trouble shooting.Conclusion

IV. Results

The system is evaluated in two steps (1) performance of question extraction (Pf) and (2) performance of retrieving the answer by using precision. The two steps are conducted by using the following formular.

Performance in question extraction (Pf) :

$$\text{Pf} = \frac{\text{Number of the correct extracted questions}}{\text{Total number of extracted questions}}$$

Sample data in this study is obtained from Call Center at True Corporation. Data was cleaned and selected for the one that related to the Internet connection problems. Then, experts in computer network answered questions from call center. These questions-answers are stored in the knowledgebase. Then, 2,800 samples are tested with this system on the performance of question extraction and precision in retrieving correct answer. Results show that question extraction performance is very good, the correctness is about 91%. Further, the precision of retrieving correct answer is about 77% ,which is good.

% correct question extraction	% correct searching
91 %	77 %

Figure 8: Comparisons of the performance of word extraction and searching

The precision of the system is not high as performance of question extraction. Since, in the process of question answering, there are some questions that should not be answered in public so the clues are not provided. Further, some provided answers in solving the Internet connection are too complex and can not be operated by novice customers.

V Conclusion

This study proposed question analysis and answering system for call center. Ontology and concept weighting are applied in this system. The system has been evaluated in two categories: performance of question extraction and precision. Then, it was tested with 2800 samples. The performance of question extraction is very good, the correctness is 91%, while system precision in searching for correct answer is 77% which is good. Future research should be done on the development of intelligent systems/agent for call center, this system can be an automatic system that help customers and company to work more efficiently and effectively.

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Searching and Ranking the Suitable Web Services with the Ontology-Based Measurements

Chun-Jung Lin, T. Chin Lo, Fan Wu*

Institution for Information Industry, Taipei, 101, Taiwan

Department of Information Management, National Chung-Cheng University, Chia-Yi, 621, Taiwan

*Corresponding author. Tel: +886-5-2721500; fax: +886-5-2721501.

Email address: kfwu@mis.ccu.edu.tw (F. Wu).

Abstract: One of the major problems for seamlessly electronic business is how to find a suitable web services. Only the syntax and semantic comparison do not precisely find the suitable web services for they are procedures embedded with a complicated thought. In this paper, we propose an effective approach based on the ontology to solve this problem. With the help of ontology-based metrics, we can measure a web service matching degree to a given request and determine the rank in which the advertisement matches the request. Simulations are also performed, and the results show that our method can have a good precision and recall rate.

Keywords: Web Services, Ontology-based metrics.

I. Introduction

The web services stack of standards is designed to support the reuse and the interoperability of software components on the web [1]. The promise of web services is to enable a distributed environment in which any number of application components can interoperate seamlessly among organizations in a platform-neutral and language-neutral fashion [2]. In the Service-Oriented Architecture (SOA), service providers develop the web services and publish the services to the UDDI (Universal, Description, Discovery and Integration) registry. When service requesters need some services, they search for the web services in the UDDI registry. If the requester finds a suitable web service, he can send SOAP (Simple Object Access Protocol) messages to invoke the web services.

Since there are many web services issued by different corporations, a critical step to find the suitable services is how to discover and find suitable web services against the request. The current services discovery approach in the UDDI registry is based on categories and keywords, as relies on the shared common understanding of services providers and requesters. Generally, the selection of keywords and the classification of categories for a same object are different for different individuals. The found web services based on the above criterion will not always precisely match the request [1]. For example, if we want to find a DogSelling service, it is clear that a PetSelling service does not match the request since the keywords, DogSelling and PetSelling, do not

match with each other in syntax. In fact, Dog and Pet have a strong relationship in semantics. But the WSDL (Web Service Description Language) used to describes the characteristics of the web service inherently can not embed the semantics of keywords in its structure.

To embed the semantic of a web service, the Web Ontology Language (OWL) is proposed as a description language of web services [9]. With the emergence of OWL, the web services can be described not only syntactically but semantically. OWL-S is another more powerful descriptive language for the web service, which can represent an OWL-based Web service ontology. The OWL-S can supply Web service providers with a core set of markup language constructs for describing the properties and capabilities of those Web services in an unambiguous and computer-interpretable form [10]. Though the web description is more expressive, the matching between the request and the web provider is not discussed until now. In this paper, we use OWL-S to complement WSDL for web services descriptions and propose an approach to make matchmaking between the requirements and the advertisements of the web services.

A web service can be formally defined as three main elements: {S, C, E}, where S, C and E denote the content descriptions, the capabilities, and the properties of end points respectively [11]. The content descriptions refer to what the web service is commented about such as the text description of the service; the capabilities refer to what the functionalities that the service provides such as what requirement is needed for performing the service and how the service performs; the properties of end points are related to the information and constraints of the end point such as cost, payment ways, response time, etc. The main elements of web services can be described by the service description language such as WSDL or OWL-S. If these main elements of the requested services are similar to those of the advertised services, we can allege that they are matched.

Former researchers consider what requirement is needed for performing the service and how the service performs as the service capabilities [3, 6]. However, the capabilities of web services become more complex and can not be just defined according to all inputs and outputs of the web services. In this paper, a complete web services discovery approach, which compares the degree of similarity between requirements and advertisements according to the whole main elements of web services, is proposed. The proposed approach is a three-metric matching approach, including text matching, construction matching, and parameter matching.

Each metric is used for examining one kind of main elements of web services between requirements and advertisements and then calculates their matching scores. In addition to the complete consideration of matching criterion, the proposed approach is based on the semantic matching.

II. Previous Work

II.1 Component Comparison and OWL-S

Since a web service accepts inputs and sends off output after processing, the task to discover web services in a UDDI registry is similar to the task of software component retrieval in a component library. For the automatic software component search and retrieval, the existing approach can be divided into four different methods [7], namely, simple keyword and string search, faceted classification and retrieval, behavioral matching and signature matching. The method of the simple keyword and string search to find the components is based on the frequency of the keywords occurring in the components. The drawback of the method is the lack of precision since the keywords cannot fully delineate the whole ability of the software component. The method of faceted classification and retrieval is to classify components based on taxonomies such as functions the software performs, types of the system, and so on. The method can have more insights about the software. However, it is difficult for software component developers to appropriately classify components based on taxonomies since that some components may overlap several categories. The third method, i.e. behavioral matching, executes each component with random inputs and generates outputs. The comparison between expected outputs and the actual outputs can help to select the matched component. But it can not perform well when the software components have complex behaviors. Precisely, assume that components have many functions. These functions may affect each other, and the behavioral matching will have low precision. The last method, i.e. signature matching, is the comparison of the function types and argument types between the components and the query specified by the user, as is the practical approach. In the area of web services discovery for web services discovery, many researchers also claim that services discovery should base on the match between a declarative description of the service being sought and a description of the service being offered [1, 3, 4, 5, 6]. Note that in this paper, the declarative description of the service being sought is called "requirement" and the one of the service being offered is called "advertisement".

Ontology defines the common words in a specified domain and the relationships between the words to represent the knowledge of the specified domain. The OWL Web Ontology Language is the W3C recommended language used to define ontology. The purpose of OWL is to describe the knowledge in specified domains and the relationships between words in each domain can be interpreted by a machine without human support. OWL has more facilities for expressing semantics than XML (eXtensible Markup

Language) and RDF (Resource Description Framework), and thus OWL goes beyond these languages in its ability to represent machine interpretable content on the Web. There are three sublanguages provided by OWL to define ontologies with three different degrees of expressive abilities. The three sublanguages are OWL Lite, OWL DL and OWL Full. OWL Full is the powerful expressive one and OWL Lite is the simplified expressive one. For each of these sublanguages, the preceding one is the descendant of the rear one. What can be expressed validly in the descendant can also be expressed validly in the elder generation.

OWL-S (Web Ontology Language for Services) is developed by the OWL Services Coalition for describing the ontology of web services. OWL-S defines the overall structure of the ontology and is divided into three parts: Service Profile, Service Process Model and Service Grounding. The part of Service Profile defines the fundamental information about this service such as service name, service text descriptions, service category, provider contact information, etc; the part of Service Process Model contains the information about how the service is constructed; the last part of Service Grounding is to define the details of how to access the service included the communication protocols, the message formats, etc. In this paper, we utilize the Service Profile since it provides the information about content descriptions, capabilities, and end points information and the Service Process Model which provides the information about service construction to make matchmaking.

II.2 Web Services Discovery and Semantic Matching

Paolucci [3] proposed a semantic matching approach that is based on the service capabilities and defined four matching degrees, namely, exact, plug in, subsume and fail, respectively. For explaining how the approach works, we use Rout and Aout to represent an output of the request and an output of the advertisement. They use four matching degrees, namely, exact, plug in, subsume, and fail, which are in descending order. Precisely, exact is the best matching degree and fail represents not matched.

Wang [1] also proposed the flexible interface matching for web service discovery. The description language used in the proposed approach is WSDL. The approach needs the service requester to provide the ideal service description and then find the matched services in the repository. They first use the vector space model to compare the information within the <documentation> tag described in natural language between the requirement and the advertisement. After the first stage, there are lists of ranked candidate web services returned. Then they use the structure matching to refine the quality of the candidate service set. The criteria used by this approach are the content descriptions, capabilities and service construction. However there is no semantic concept in this approach because of the used description language, WSDL.

Paolucci [3] proposed the semantic web services matching based on services capabilities. Many researchers

have cited the proposed concept for making a semantic web services matchmaking. The criterion used by this approach is the service capability. The proposed approach is good at the matching of the service capabilities but is weak for using only one criterion for matching.

Sirin [6] proposed two filters for selecting semantic web services including the input/output matching and the parameter matching. The proposed approach uses the criteria of capabilities and properties of end points to make a semantic web services matching. However the lack of the criteria including content descriptions and the service construction will reduce the precision and recall of the matching. The following table shows the comparison of these approaches.

Table 1. The comparison of the related research

	Service description language	Criteria	Matching approach
Wang [1] 2003	WSDL	Content descriptions; Capabilities; Construction	Vector-space model; Structure matching
Paolucci [3] 2002	DAML-S	Capabilities	Semantic matching approach
Sirin [6] 2003	OWL-S	Capabilities; End point information	Semantic matching approach; Parameter matching

III. Ontology-based Comparison Approach

This paper proposes a three-metric matching approach for finding suitable web services for requesters according to the criteria of content descriptions, service capabilities, service construction and properties of end points. The three metrics includes text matching, construction matching, and parameter-matching. The first metrics can filter the most irrelevant advertisements in the registry and give the qualified services the ranking. The remaining two metrics, i.e. the construction matching and the parameter matching, are used to refining the initial ranking of the qualified advertisements. Finally, lists of ranked web services are returned to the requester.

Before the matchmaking, the requesters are assumed to figure out what web services they need in an OWL-S format. In other words, the requester should provide an OWL-S file describing the ideal service. Then the proposed approach compares the description with the advertisements in the registry and returns the required web services. The proposed metrics work sequentially when the comparison of the degree of similarities between the requirement and each advertisement are executed. Each metric can produce one matching score. Therefore there are three matching scores produced for each advertisement. Then the relevant web

services are returned according to the degree of the similarities. The following is the metrics used in the proposed approach.

III. 1 Text Matching

Many methods for text matching have been proposed in the field of IR. The simple and realistic method is the vector space model [12]. In the Service Profile of OWL-S, there is an optional tag, <profile:textDescription>, in which the service providers can have some comments in natural language for their services and the requesters can describe what their ideal requirements are. According to the vector space model, the part commented in natural language can be treated as a multi-dimensional vector. Each term in the part can represent one dimension in the vector. The weight of each dimension in the vector is directly proportional to the frequency that the term occurs in the document and inversely proportional to the number of documents which contain the term. The weight can be computed according to the following formulas:

$$W_{ij} = tf_{ij}idf_i,$$

$$idf_i = \log_2(N/df_i),$$

Where W_{ij} represents the weight of the dimension i in the vector. tf_{ij} represents the number of occurrences of the term i in document j . idf_i represents the result of the total number of documents divided by the number of documents which contain the term i . N represents the total number of the documents. df_i represents the number of documents which contain the term i .

For restraining the impact of idf_i , \log_2 is used to dampen the effect relative to idf_i [13]. Thus we have two vectors respectively for the requirement and the advertisement, and we can derive the similarity coefficient of the two vectors from the production of them. For each advertisement, our approach will return a similarity coefficient derived from the comparison. The derived similarity coefficient is the matching score of the text matching.

III. 2 Construction Matching

The construction matching is the consideration of which processes the inputs and outputs belong to. In the construction matching, we utilize the information provided by Service Process Model of OWL-S. The comparison of the construction is a multi-step process: it involves the comparison of the processes between the requirement and the advertisement, which is based on the comparison of the compositions of the inputs and outputs within the processes. In the input/output matching, we compare all the inputs and outputs between the requirement and the advertisement. In

the construction matching, we compare all of the inputs and outputs within one process in the requirement to all of the inputs and outputs within one process in the advertisement. Therefore we can get the matching score of each pair-wise process between the requirement and the advertisement. The pair-wise processes can form many kinds of combinations like the combinations in the input/output matching. Then we find the combination with the highest score among all the combinations. Finally we can define the highest score of the construction matching between the requirement and the advertisement as the construction matching score.

III.3 Parameter Matching

The parameter matching utilizes the information provided by Service Profile of OWL-S to examine the matching score of the properties of end points between the requirement and the advertisement. The parameter matching can be considered as adding the constraints into the matching processes for finding the suitable web services. The parameter in the parameter matching can be divided into two parts. The first part is the OWL-S predefined parameters such as `contactInformation` and `ServiceCategory`. The comparison of parameters in this part needs to find the corresponding parameter name between the requirement and the advertisement and then compare the value of each attribute of the parameter. If the value of each attribute of the parameter in the requirement is the same with the value of each corresponding attribute of the corresponding parameter in the advertisement, we define that the two parameters between the requirement and the advertisement are matched. We define the matching scores according to the numbers of the matched parameters. Each matched parameter desires 10. The second part is the self-defined parameters such as the service quality rating. The comparison of parameters in the part needs to first compare the parameter names between the requirement and the advertisement. If the parameter names are the same, we can compare the value of the parameters. Because the value of the parameter is an URI referring to the class in the ontology, we use the semantic matching approach to compare the value of the parameter. As the above mention, the matching degree of the Exact level is defined as score 10; the Plug-in level is defined as score 6; the Subsume level is defined as score 4; the Fail level is defined as score 0. Finally we accumulate each matching scores and the total score represent for the matching degree of the parameter matching.

III.4 Ranking System

The three metrics introduced above can produce three scores for representing the matching degree between the requirement and the advertisement. First we can utilize the two scores derived from text matching and input/output matching to filter the most irrelevant advertisements. We use the formulation to representing how it works.

$$\text{Relevant Score} = W_1 * S_1 + W_2 * S_2, \text{ where } W_1 \text{ and } W_2$$

are used for normalizing S_1 and S_2 to avoid either of them influence the relevant score too much. S_1 and S_2 denote the scores derived from text matching and input/output matching respectively.

We can set a threshold for the relevant score. If the relevant score between the requirement and the advertisement is higher than the threshold, the advertisement is considered as qualified for the candidates. After we have the candidates, we need to rank them according to their matching degree. We use the following formulation to represent how to do it.

$$\text{Matching Score} = \text{Relevant Score} + W_3 * S_3 + W_4 * S_4,$$

where W_3 and W_4 are used for normalizing S_3 and S_4 to avoid that either of them influence the matching score too much. S_3 and S_4 denote the scores derived from construction matching and parameter matching respectively. We can rank the qualified advertisements according to the matching scores in descending. Therefore we can return the suitable ranked services to the service requester.

IV. Evaluation Method

The proposed three metrics can be implemented to develop the matching system. We use Java language to implement the system. The OWL-S API developed by MINDSWAP (Maryland Information and Network Dynamics Lab Semantic Web Agents Project) helps us to parse the OWL-S document [14]. The RACER system [15] is an OWL reasoner system. It helps us to identify the relation of the input/output between the requirement and the advertisement and we can proceed the semantic matching and define the matching score of the input/output matching and the construction matching. At present the general web service description language is WSDL. However, our approach uses the OWL-S for the web service description language. We need to translate WSDL to OWL-S first and then we can use our system to make a matchmaking. The WSDL2OWL-S developed by the Softagents Lab of Carnegie Mellon University can help us to translate the WSDL document to OWL-S document. The whole system architecture is shown in figure 1.

To evaluate the proposed approach, we have to collect lots of WSDL documents of web services as the advertisements. The XMethods [16] is a web site which provides lots of web services for users to give a trial. We can collect the WSDL documents from the web site to form the advertised collection. Then we classify the collection into several categories. We take one advertisement from one of the categories as the requirement. After executing the comparison of the proposed approach, the matching system will return lists of suitable web services. If the returned service is same category with the requirement, we define that it is relevant. Otherwise, the returned service is not

relevant. Based on the definition of the relevance, we can compute the precision and recall for our proposed approach. The way to compute the precision and recall is defined as follows:

$$\text{Precision} = \# \text{ of Relevant retrieve} / \# \text{ of Retrieve};$$

$$\text{Recall} = \# \text{ of Relevant retrieve} / \# \text{ of Relevant}.$$

The two metrics are chosen for the experiments. In the search for the web service, we limit up 5 UDDI server to be accessed. All the retrieval web services are ranked, and only the top 30 web services are returned by our web service search engine through the proposed criterion. The simulation results for the requests of “translation_from_mile_to_kilometer” and “translation_from_French_to_English” are summarized in Figures 2 and 3, respectively. From these two tables, we can find some interesting characteristics. First, we found the retrieval for the request “translation_from_mile_to_kilometer” has higher precision than that for the request the request “translation_from_French_to_English”. Since the former request has less descriptive vocabularies than that of the second one. Perhaps the metric of the text matching will let more possible web services to enter the second and third metric comparison. And the second and third metric can have a better rank ability for the simple request. However, the recall rate for the former request is smaller than that of the latter one. It is guessed that the former has less characteristic than the latter. The judge of similarity in the former is more difficult than the latter.

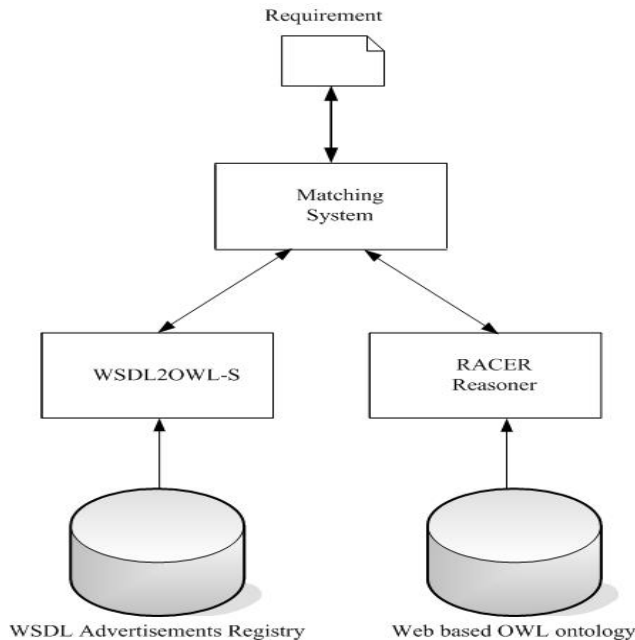
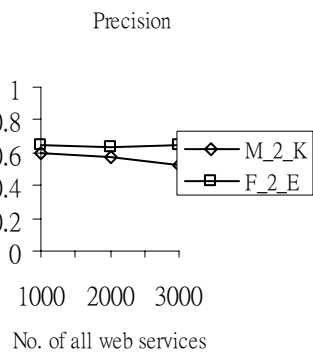
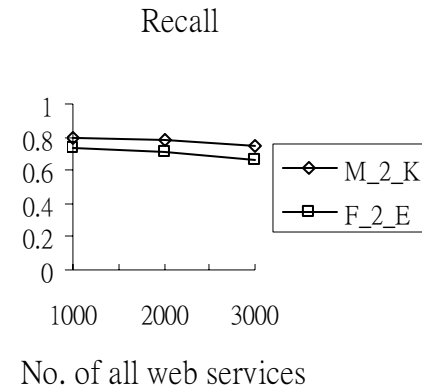


Figure 1. The system architecture



Figures 3 and 4. The recall and precision rates of web service searching for the M_2_K (Mile_to_Kilometer) and F_2_E (French_to_English).

V. Conclusion

As the application of Web services grow exponentially, it has become a crucial problem to provide effective search tools to increase the speed and precision of searching for the suitable ones. The credit assignment for the ranked search can be significantly improved by adequate metrics. In this paper, we propose a method to assign the order of web services for a request. The extensive simulation is performed and shown that our method can effectively estimate the proper suitability of web services.

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